EPA Contract No. 68-W9-0036
EPA Work Assignment No. 36-1L57

EPA Deputy Project Officer: Filomena DiNardo
EPA Remedial Project Manager: Donald McElroy

REMEDIAL INVESTIGATION FINAL REPORT

Volume I
Text

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, Massachusetts

September 1997

Metcalf & Eddy
An Air & Water Technologies Company

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ACRONYMS AND ABBREVIATIONS

ADD	Average Daily Dose
ADI(s)	Allowable Daily Intake(s)
AET	Apparent Effect Threshold
ARCS	Alternative Remedial Contracting Services
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criteria
B&M	Boston and Maine
BEHP	Bis(2-ethylhexyl)phthalate
BHC(s)	Benzene Hexachloride(s)
BOD	Biological Oxygen Demand
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
cm^2	square centimeters
C	Celsius
$CaCO_3$	Calcium Carbonate
CDM	Camp Dresser & McKee, Inc.
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Cl	Chloride
CLP	Contract Laboratory Program
COD	Chemical Oxygen Demand
COPC(s)	Chemical(s) of Potential Concern
CPOM	Coarse Particulate Organic Matter
DAS	Delivery of Analytical Services
DCA	Dichloroethane
DCB	Dichlorobenzene
DCE	Dichloroethene
DDD	Dichlorodiphenyl Dichloroethane
DDE	Dichlorodiphenyl Trichloroethene
DDT	Dichlorodiphenyl Trichloroethane
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DOE	Department of Energy
Eh	Oxidation-Reduction Potential
EM	Electromagnetic Survey
EPA	United States Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, Tricoptera
ERA	Ecological Risk Assessment
ER-L	Effects Range-Low
ER-M	Effects Range-Medium
ET	Ecotox Threshold
F_{oc}	Fraction of organic carbon

ACRONYMS AND ABBREVIATIONS (Continued)

F	Fahrenheit
gpm	gallons per minute
g/cm^3	gram per cubic centimeter
g/g	gram per gram
GC	Gas Chromatograph
GPR	Ground Penetrating Radar
GZA	Goldberg, Zoino, and Associates
HEAST	Health Effects Assessment Summary Tables
HI	Hazard Index
HPLC	High Pressure Liquid Chromatography
HSL	Hazardous Substance List
HQ	Hazard Quotient
ID	Inner Diameter
ILCR(s)	Incremental Lifetime Cancer Risk(s)
IRIS	Integrated Risk Information System
kg	kilogram
K_d	Distribution Coefficient
K_h	Henry's Law Constant
K_{oc}	Organic Carbon Partition Coefficient
K_{ow}	Octanol/Water Partition Coefficient
LADD	Lifetime Average Daily Dose
LD	Lethal Dose
LEL	Lowest Effect Level
LNAPL	Light Non-Aqueous Phase Liquid
LOAEL	Lowest Observed Adverse Effect Level
LOEL	Lowest-Observed-Effect-Level
µg/kg	microgram per kilogram
µg/l	microgram per liter
µl	microliter
µmhos/cm	micromhos per centimeter
mg/kg	milligram per kilogram
mg/l	milligram per liter
mg/cm^2	milligrams per square centimeter
ml	milliliter
ml/g	milliliter per gram
ml/min	milliliter per minute
mmho/m	millimhos per meter
m^2	square meter
mph	miles per hour
m/s	meter per second
mV	millivolts

ACRONYMS AND ABBREVIATIONS (Continued)

M&E	Metcalf & Eddy, Inc.
MADEP	Massachusetts Department of Environmental Protection
MBTA	Massachusetts Bay Transportation Authority
MCL(s)	Maximum Contaminant Level(s)
MCP	Massachusetts Contingency Plan
MEK	2-Butanone or Methyl Ethyl Ketone
MGIS	Massachusetts Geographic Information System
MHS	Massachusetts Historical Commission
MIBK	4-Methyl-2-Pentanone or Methyl Isobutyl Ketone
NAPL	Non-Aqueous Phase Liquid
NGDV	National Geodetic Vertical Datum
No.	Number
NO_3/NO_2	Nitrate/Nitrite
NOAEL	No Observed Adverse Effect Level
NPL	National Priorities List
NTU	Nephelometric Turbidity Units
OD	Outer Diameter
OMEE	Ontario Ministry of Environment and Energy
OSWER	Office of Solid Waste and Emergency Response
ppb	part per billion
ppm	part per million
psi	pounds per square inch
PAH(s)	Polycyclic Aromatic Hydrocarbon(s)
PCB(s)	Polychlorinated Biphenyl(s)
PCE	Tetrachloroethene
PID	Photoionization Detector
PVC	Polyvinyl Chloride
QC	Quality Control
R	Retardation factor
RAGS	Risk Assessment Guidance for Superfund
RAS	Routine Analytical Services
RBC(s)	Risk-based Concentration(s)
RCRA	Resource Conservation and Recovery Act
RfD(s)	Reference Dose(s)
RI/FS	Remedial Investigation/Feasibility Study
RI	Remedial Investigation
RME	Reasonably Maximum Exposed
RSI	Reclamation Services, Inc.
SAS	Special Analytical Services
SF(s)	Slope Factor(s)
SO_4	Sulfate

ACRONYMS AND ABBREVIATIONS (Continued)

SOW	Scope of Work
SQB	Sediment Quality Benchmark
SQL(s)	Sample Quantitation Limit(s)
SVOC(s)	Semivolatile Organic Compound(s)
TAL	Target Analyte List
TCA	Trichloroethane
TCE	Trichloroethene
TCL	Target Compound List
TCO	Total Combustible Organics
TDS	Total Dissolved Solids
TIC	Tentatively Identified Compound
TOC	Total Organic Carbon
Total P	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TRV(s)	Toxicity Reference Value(s)
TSS	Total Suspended Solids
UCL	Upper Confidence Limit
VOC(s)	Volatile Organic Compound(s)
USFWS	U.S. Fish and Wildlife Service
WQPs	Water Quality Parameters
%	Percent

EXECUTIVE SUMMARY

A remedial investigation (RI) was conducted by the Metcalf & Eddy team for EPA Region I at the Iron Horse Park Superfund Site, Operable Unit 3, in North Billerica, Massachusetts. The objectives of the RI were to define the source(s), nature, extent, and distribution of contaminants released; determine and quantify the potential exposure pathways; and assess public health and ecological risks at the Site.

The Site occupies approximately 500 acres of land and includes an active industrial complex (the Iron Horse Industrial Park), a railyard, numerous manufacturing operations, open storage facilities, landfills, and lagoons. The site study area consists of 10 areas of concern including the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Old Sludge Recycling Area, the Contaminated Soil Area, the Asbestos Landfill, the Asbestos Lagoons, PCB Contamination, Groundwater Contamination, and Site-Wide Surface Water and Sediment Contamination.

Field investigative activities were conducted in two phases. The first phase consisted of a site reconnaissance, surface geophysical surveys, test pit excavation and sampling, soil boring advancement and sampling, groundwater screening, surface soil sampling, and surface water and sediment sampling. An interpretive evaluation of the geologic and hydrogeologic field data was presented in the Hydrogeological Assessment (M&E, 1994a) and served as the basis for additional field activities conducted as part of a second phase. These activities included additional surface geophysical investigations, installation of piezometers, monitoring wells, seepage meters, and staff gauges, water level measurements, groundwater sampling, aquifer testing, site surveying, and site mapping.

Site-wide Summary

Bedrock underlying the Site is comprised of granite, schist, and diorite. A bedrock trough trending northeast and northwest, and bedrock fractures trending north-northeast and east-west, were encountered. The overburden primarily consists of glacial drift deposits including basal and ablation till and glacial outwash. Peat deposits were encountered near streams, ponds, and wetlands.

Groundwater in both the overburden and bedrock aquifer enters the Site from the southwest and flows to the northeast. Similarly, surface water flows from the south to the northeast. The potential for groundwater discharge to surface water was evident throughout most of the Site.

Elevated metal concentrations and organic compounds including pesticides, PAHs, and petroleum hydrocarbons were found in soil. Volatile organics, phenolics, and PCBs were also frequently detected in subsurface soils. The types of organic compounds and metals detected in groundwater were similar to soils in each area of concern; however, the frequency of detection and concentrations measured were typically less than those in soil. No trend over time was evident between groundwater sampling rounds. The types and depths of contaminants found indicate the potential for LNAPL and DNAPL in isolated areas of the Site, although only LNAPL was found.

In surface water, elevated concentrations of metals and organic compounds, including VOCs, PAHs, phenolics, and pesticides, were measured throughout the Site; however, the types of analytes and the concentrations detected were localized in extent. Organic compounds and metals were also detected in sediment across the Site. Organic compounds detected included PAHs, petroleum hydrocarbons, pesticides, and PCBs.

Potential migration pathways at the Site include transport through the unsaturated zone by percolation through wastes and contaminated soil, transport in the saturated zone by groundwater, and transport to surface water and sediment by overland flow and discharge from groundwater. Although adsorption may be the dominant fate mechanism for most contaminants in the overburden, advection may dominate in fractured bedrock zones. While the high organic carbon content of surface and subsurface soils act to retain many organic compounds and metals, the more mobile organic compounds (chlorinated and aromatic VOCs) that were found in higher concentrations in groundwater have the potential to migrate further downgradient. Due to the high organic carbon content of sediments, adsorption is likely the primary attenuation mechanism for contaminants in surface water. PCBs were prevalent in sediments in the Middlesex Canal from past discharges from the former Johns-Manville facility.

Elevated blood lead levels may result from indoor occupational exposures of female workers to Site soils in the B&M Locomotive Shop Disposal Area and the Contaminated Soil Area, particularly the metals hot spot evaluated. Potential human health risks for carcinogens and/or noncarcinogens were above EPA's target risk range for site groundwater in five areas of concern, based on future use as a potable drinking water source. Contaminants responsible for the majority of the risk were arsenic and manganese. Other contaminants contributing to site risk included benzene, beryllium, and thallium. Substantial human health risks from surface water and sediment did not exceed EPA's target risk range.

Ecological risks were also identified at the Site. These risks included potentially significant reductions of both soil invertebrate and small mammal populations due to SVOCs and metals in surface soil in the B&M Railroad Landfill, the B&M Locomotive Shop Disposal Areas, and the RSI Landfill, and potential risk to aquatic life from metals surface water contaminants in three lentic (standing water) habitats: Wetland 2 group (Central Wetlands), Richardson Pond Wetlands and Content Brook Wetlands. Risk from chronic exposure of aquatic life to copper, SVOCs and acenaphthene in sediment was also found. In addition, risk to migratory bird populations from incidental ingestion of mercury, zinc, and/or dibenzo(a,h)anthracene in sediment, and from ingestion of fish in three lentic habitats (Wetland 2 group, Richardson Pond Wetlands, and Content Brook Wetlands), was found. Potential risk to sedentary aquatic receptors from high concentrations of PCBs, copper, lead, and pesticides in some areas of the West Middlesex Canal was also measured.

Conclusions

The RI indicated that 1) contaminants were detected in all media, 2) contaminant transport at the Site is primarily affected by groundwater flow, geologic features, groundwater/surface water interaction, and the organic content of soils and sediments, and 3) certain site contaminants, predominately metals and SVOCs, present potential risks to human health and ecological receptors.

SECTION 1.0
INTRODUCTION

The Iron Horse Park Superfund Site in North Billerica, Massachusetts (the Site) was placed on the National Priorities List (NPL) in September 1984 as a result of a site investigation report prepared for EPA (NUS, 1983) and Massachusetts Department of Environmental Protection (MADEP) investigations. The first remedial investigation (RI) at the Site, the Phase 1A RI, was conducted in 1985 by Camp Dresser & McKee, Inc. (CDM), under contract to the EPA (CDM, 1987). The Phase 1A RI delineated potential problem areas at the Site. The Site includes three operable units. The 1st operable unit is the Boston & Maine (B&M) Wastewater Lagoons, the 2nd operable unit is the Shaffer Landfill, and the 3rd operable unit is the remainder of the Site.

This document is a comprehensive, interpretive report on the RI portion of the remedial investigation/feasibility study (RI/FS) conducted at the 3rd operable unit of the Site. This RI was conducted for Region I of the U.S. Environmental Protection Agency (EPA) by Metcalf & Eddy (M&E) under the Alternative Remedial Contracting Services (ARCS) contract. The RI was undertaken to document the nature and extent of contamination observed at the Site so that remedial alternatives can be developed and the appropriate response action or actions can be implemented.

1.1 SITE STUDY AREA

Due to the large size of the Iron Horse Park Superfund Site and the number of potential source areas, a phased operable unit approach was undertaken to select remedies for each identified source area. The intent of this approach is to remediate the Site more effectively by establishing priorities for potential source areas and then conducting a separate but overlapping RI on each designated source area or "operable unit," rather than attempting to remediate all source areas simultaneously (NUS, 1983).

As a result of the Phase 1A RI, 12 areas of concern identified at the Site were divided into three operable units: the B&M Wastewater Lagoons (operable unit 1), the Shaffer Landfill (operable unit 2), and the remaining 10 areas of concern (operable unit 3) including the B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas (A and B), the RSI Landfill, the Old B&M Oil/Sludge Recycling Area, the Contaminated Soil Area, the Asbestos Landfill, Asbestos Lagoons, PCB Contamination, Groundwater Contamination, and Site-Wide Surface Water and Sediment Contamination. These areas were addressed in this investigation.

The area of study evaluated during the RI included not only the applicable portions of the Site, but also surrounding areas and water bodies that are potentially affected by the 3rd operable unit. For this reason, the entire study area evaluated during the RI is referred to throughout this report as "the Site." Figure 1-1 shows the area of study evaluated during the RI.

A hydrogeological report prepared by Metcalf & Eddy (1994a) provided a preliminary evaluation of groundwater flow direction at the Site. In addition, groundwater screening results and soil boring results were discussed. Findings in the hydrogeological report indicated the potential for groundwater contamination at the Site in several source areas. To evaluate groundwater, additional field work was conducted to install monitoring well clusters up and down gradient of each source area for evaluation of potential groundwater contamination by area.

1.2 SITE BACKGROUND

This section identifies previous investigations and summarizes information describing the Site and its history. Information presented in this section was summarized from the Phase 1A RI report (CDM, 1987), the CDM memorandum report (CDM, 1989a), and the EPA's Statement of Work for the 3rd operable unit (U.S. EPA, 1992d).

1.2.1 Site Description

The Site occupies approximately 553 acres of land in North Billerica, Massachusetts, near the Tewksbury town line, approximately 20 miles northwest of Boston (Figure 1-1). The Site is bounded on the north by the B&M railroad tracks, on the west by High Street and an auto salvage yard, on the east by Gray Street, and on the south by a wetland, Pond Street, and the Middlesex Canal (Figure 1-2). The B&M railroad tracks border the Shaffer landfill on the north and the Middlesex Canal borders it to the south. The Middlesex Canal flows through the Site to the east, where it joins Content Brook at the southeastern edge of the Shaffer landfill. There are also abundant wetlands at the Site.

The Site contains an active industrial complex, called the Iron Horse Industrial Park, and a rail yard with a long history of activities that have resulted in contamination of soils, groundwater, surface water, and air at the Site. The Site includes numerous manufacturing operations, open storage areas, landfills, and lagoons, some of which began operating in the early 1900s. Changes in physical characteristics of the Site have occurred during the years of operation, due to the operation and expansion of several landfills, open storage areas, and lagoons. Contaminants known to have been disposed of at the Site include asbestos, PCBs, solvents, waste oils, and other chemicals (CDM, 1987) and are discussed in section 1.2.5 in relation to the areas of concern.

1.2.2 Site History

The 553 acres of land that now makes up the Site were first purchased by the B&M Railroad (now known as B&M Corporation) in 1911. Prior to that year, the Site consisted of approximately 18 privately owned parcels that were consolidated by the B&M Corporation in 1911. Land-use records for these parcels prior to 1911 were not recorded in the county or town archives, according to the Middlesex County Registry of Deeds and the Billerica assessors' office. However, since 1911, a variety of industrial disposal practices have resulted in the creation of numerous lagoons, landfills, and open storage areas at the Site, which complicate the process of delineating the origin and nature of the current contamination problems. Table 1-1 provides a chronology of activities at the Site.

The B&M Railroad has conducted operations at the Site since 1913, including the operation of an oil and sludge recycling area beginning sometime prior to 1938. At various times over the years, the B&M Corporation has sold and leased several parcels of the land and some of the buildings on the Site to various companies. At the present time, the B&M Corporation's on-site facilities and operations include administrative offices, a locomotive/railroad car maintenance and repair facility, track panel fabrication, and rail welding.

The B&M Railroad has operated the Site's sewage collection system since 1924. The system includes subsurface sewer lines, a dismantled pump house, two unlined filter lagoons (approximately 104 feet by 200 feet by 4 feet), and one overflow lagoon (these wastewater lagoons are operable unit 1). These lagoons received septic waste from B&M facilities and other manufacturing facilities throughout the park. In addition to septic wastes, the lagoons also received industrial/hazardous wastes such as solvents, waste oils, and other chemicals from various floor and yard drains found throughout the industrial park. Sludge from the bottom of these lagoons was periodically dredged during the past 60 years of operation and deposited in piles adjacent to the lagoons.

Prior to 1981, large quantities of hazardous wastes were discharged directly to these wastewater lagoons. After 1981, much of the hazardous waste generated at the Site was disposed of off site at RCRA-permitted treatment, storage, and disposal facilities, in compliance with state and federal hazardous waste regulations. However, wastes from various cleaning and repair operations may have been discharged directly to the lagoons through floor and yard drains (CDM, 1987). Presently, the sewage collection system no longer discharges to the lagoons but has been tied into the Billerica sewer system.

In 1944, the B&M Railroad sold approximately 70 acres of land located in the western portion of the Site to Johns-Manville Products Corporation, which at that time began to manufacture structural insulating board that contained asbestos. Three unlined lagoons were built to dispose of the resulting asbestos sludge waste. At approximately the same time, the B&M Railroad leased approximately 15 acres of land located in the eastern portion of the Site to Johns-Manville to be used as a landfill for asbestos sludge and other asbestos mill wastes generated by their manufacturing operations. EPA capped this landfill in 1984 as part of an "Immediate Removal Action" under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

In 1961, the Johns-Manville Products Corporation sold the western portion of its land to the General Latex and Chemical Corporation, which manufactured acrylic and vinyl acetate polymers and copolymers used in fabrics, paper, and insulation. Latex and polymerization wastes were treated on site using flocculation, coagulation, and sand filters, producing a filter cake that was disposed of off site at a sanitary landfill. The liquid filtrate was discharged to the ground through sand filters. This practice was discontinued in May 1982, when General Latex was connected to the Billerica sewer system.

Aerial photographs indicate that in 1961 B&M Railroad began to fill in the wetland area located just east of the rail yard, on the north side of the Middlesex Canal (west of Pond Street), as reported by CDM (1989a). The photographs also indicate that another wetland area owned by the B&M Railroad, located on the east side of Pond Street, was also being filled in. Also in 1961, the B&M Railroad sold a 23-acre parcel of land containing the oil and sludge recycling area to Omega Trust. In 1962, the B&M Corporation sold approximately 1.2 acres of land and an existing building to Wood Fabricators, Inc. In 1966, the B&M Corporation sold an additional 0.67 acres of land to Wood Fabricators, Inc.

In 1966, the B&M Corporation sold 106 acres of land north of the Middlesex Canal and east of Pond Street to Phillip Shaffer as the Trustee of Gray Pond Realty Trust. This land later became the Shaffer Landfill and is currently the second operable unit of the Site. Prior to 1966, this parcel of land had been used as an open burning dump operation with approval from the Billerica Board of Health. The area was originally a flat wetland area, which was mostly filled in by 1966. From 1966 until 1968, burning practices continued until the Billerica Board of Health issued regulations in 1968 stating that no further burning could take place. The regulations also required that all refuse be placed above the water table and that daily cover be applied. Since that time the area has been used as a landfill, referred to as the Shaffer Landfill, operated by Middlesex Disposal Services, Inc. This landfill received commercial and residential waste materials from private clients, wastewater treatment sludge from the town of Billerica, and domestic waste from Billerica residents.

- The Shaffer Landfill has been cited for many violations of federal and state regulations under the Clean Water Act and the Solid Waste Regulations (CDM, 1987). At the present time, MADEP is conducting interim operation and maintanence (post-closure) at the landfill. In compliance with the state court order, the landfill stopped receiving waste of any kind in April 1986.

Aerial photographs taken in 1969 indicate that landfill areas located in the central portion of the Site were expanding significantly. These areas included the B&M land being used by Johns-Manville for disposal of asbestos waste, the B&M Railroad landfill north of the Middlesex Canal (west of Pond Street) being used by B&M to dump various kinds of materials, and the Shaffer Landfill. Also according to 1969 aerial photographs, the B&M Railroad Corporation was using a parcel of land located just east of the railyard on the south side of the Middlesex Canal as a borrow pit for sand and gravel. This borrow pit area was leased by B&M Corporation to Reclamation Services, Inc., (RSI) for use as a landfill to dispose of municipal and light industrial waste. Aerial photographs taken in 1976 indicate that the expansion of the existing landfill areas had slowed or stopped and that vegetative cover had returned in portions of each landfill.

In 1973, the land containing the Old B&M Oil/Sludge Recycling Area, previously owned by the B&M Corporation, was sold by Omega Trust to the Penn Culvert Company. An aerial photograph taken in 1979 shows that the Old B&M Oil/Sludge Recycling Area, now located on Penn Culvert property, had been cleared, leveled, and filled. The area is currently a partially paved lot and is used as a storage area by Penn Culvert.

In 1976, the B&M Corporation sold approximately 150 acres of primarily developed land to the Massachusetts Bay Transportation Authority (MBTA), which has since used the land to operate passenger rail service. The B&M Corporation now leases much of this land from the MBTA.

The B&M Corporation presently owns approximately 100 acres of the Site. Other current landowners and operating companies at the Iron Horse Industrial Park include: General Latex, Penn Culvert, Spincraft, Wood Fabricators, BNZ Materials, and George McQuesten Lumber (Figure 1-3).

1.2.3 Previous Studies and Reports

Several studies have been conducted at the Site prior to the initiation of the RI. These studies have generated reports and maps concerning the Site. Some of the studies are listed below:

- NUS Corporation (NUS). 1975. *Final report for Iron Horse Park Site inspection, North Billerica, MA*

- Ecology and Environment. 1982. *Field investigations of uncontrolled hazardous waste sites (FIT Project): scope of work for site inspection and investigation, Iron Horse Park, Billerica, MA*

- NUS Corporation (NUS). 1983. *Preliminary site assessment of the Iron Horse Park Facility, North Billerica, MA*

- GHR Engineering Corporation. 1984. *Final environmental impact report, Pond Street Sanitary Landfill, Billerica, MA*

- GHR Engineering Corporation. 1985. *Supplemental final environmental impact report, Pond Street Sanitary Landfill, Billerica, MA*

- Camp Dresser and McKee (CDM). 1987. *Draft phase 1A remedial investigation for the Iron Horse Site, Billerica, MA*

- Goldberg, Zoino, and Associates (GZA). 1987. *PCB investigation report, Manville Corporation, North Billerica, MA*

- Camp Dresser and McKee (CDM). 1988. *Draft phase 1B remedial investigation for the Boston and Maine Wastewater Lagoon Area, Iron Horse Park Site, Billerica, MA*

- GHR Engineering Corporation. 1988. *Supplemental hydrogeologic and water quality assessment at the Pond Street Landfill, Billerica, MA*

- Camp Dresser and McKee (CDM). 1989b. *Draft phase 1C remedial investigation for the Shaffer Landfill, Iron Horse Park Site, Billerica, MA*

- Weston Environmental (Weston) 1989. *Wetland characterization and biological investigations, Iron Horse Park Site, Billerica, MA*

- Camp Dresser and McKee (CDM). 1991. *Final draft phase 1C feasibility study for the Shaffer Landfill, Iron Horse Park Site, Billerica, MA.*

1.2.4 Current Studies and Reports

The following reports were prepared as part of the current RI as outlined in M&E's Final Work Plan and Work Plan Amendment (1993a and 1994e, respectively) or to provide the necessary background information to conduct the RI. The reports include :

- Metcalf and Eddy, Inc. (M&E). 1994a. *Hydrogeological Assessment Report - Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, MA*
- Metcalf and Eddy, Inc. (M&E). 1994b. *PCB Contamination Evaluation Report - Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, MA*
- Metcalf and Eddy, Inc. (M&E). 1994c. *Asbestos Landfill Cap Evaluation Report- Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, MA*
- Metcalf and Eddy, Inc. (M&E). 1995. *Ecological Characterization for Remedial Investigation-Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, MA*

In addition, the following report was prepared in conjunction with the remedial design activities at the 2nd and operable unit, Shaffer Landfill:

- Metcalf and Eddy, Inc. (M&E). 1993e. *Wetlands Characterization Report - Shaffer Landfill, Billerica, MA*

1.2.5 Identification of Contamination

Historical sampling data for groundwater, surface soil, subsurface soil, surface water, and sediment from nine potential source areas within the Site has indicated the presence of contaminants (CDM, 1987). The CDM memorandum report (CDM, 1989b) describes the current understanding of the Site and addresses concerns associated with the different operable units that were identified in the Phase 1A RI report (CDM, 1987).

This section briefly describes contamination previously detected at the areas of concern that comprise the 3rd operable unit (Figure 1-2), using sections and excerpts from the CDM memorandum report (CDM, 1989b) and from the Statement of Work (SOW) for this assignment (U.S. EPA, 1992d). These areas include: the B&M Railroad Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the RSI Landfill, the Old B&M Oil/Sludge Recycling Area, the Contaminated Soil Area, Asbestos Contamination (including the Asbestos Landfill and Asbestos Lagoons), PCB Contamination, Groundwater Contamination, and Site-Wide Surface Water and Sediment.

1.2.5.1 B&M Railroad Landfill and B&M Locomotive Shop Disposal Areas. The B&M Railroad historically used two distinct areas for disposal, the B&M Railroad Landfill and the B&M Locomotive Shop Disposal Areas, at the Site.

B&M Railroad Landfill. The B&M Railroad landfill is approximately 14 acres in size and is located in a wetland area, to the north of the Middlesex Canal and east of the railyard. The wetland was filled in by the B&M Railroad and used to dispose of various kinds of debris. CDM (1987) observed that this area contains partially buried drums and railroad ties with creosote. Soil samples from this area were not collected during the Phase 1A RI. Surface water and sediment samples were analyzed from two locations in the Middlesex Canal (which borders the area), and the results indicated no detectable levels of contaminants. However, a cluster of groundwater monitoring wells (OW-49/50/51) located on the eastern edge of this wetland revealed detectable levels of volatile organic compounds in the bedrock well (90 ppb) and the deep overburden well (6 ppb).

B&M Locomotive Shop Disposal Areas. The B&M Locomotive Shop Disposal Areas consist of two disposal areas separated by a manmade channel that flows into an unnamed brook. The first area, located on the north side of the channel and approximately 1 acre in size, was investigated by CDM during the Phase 1A RI. This area is referred to as Area A throughout the report. Various kinds of partially buried debris were observed in Area A. Two soil borings drilled in this area revealed that subsurface soils were visibly contaminated with oily wastes. Chemical analysis for contaminants on the hazardous substance list (HSL) revealed elevated levels of lead and polynuclear aromatic hydrocarbon (PAH) compounds (3,000 ppm and 4 ppm, respectively). Trace levels (5 ppb) of volatile organic compounds (VOCs) were also detected. In addition, analysis of surface soils for asbestos revealed levels greater than 1%.

The second area located on the south side of the channels is approximately 3 acres in size and is referred to as Area B. According to the CDM memorandum report (1989), prior to 1938 and until about 1979, Area B was used to dispose of various kinds of "light and dark-toned materials." CDM observed that the area contains various kinds of debris, including deteriorated drums. The soils in this area were not sampled as part of the Phase 1A RI.

1.2.5.2 RSI Landfill. The RSI Landfill is located east of the B&M railyard near the Johns-Manville Asbestos Landfill. The RSI Landfill is 6 acres and is bounded on the south by an unnamed brook and on the east by a wetland, which is drained by the Middlesex Canal. This area was used by B&M as a borrow pit for sand and gravel sometime between 1961 and 1969.

This 6-acre parcel now comprising the RSI Landfill was leased by the B&M Corporation to RSI for a period of three months (from June of 1971 until August of 1971) because of a fire at the RSI plant in Cambridge. During the fire, some compacted refuse bales were broken apart to extinguish the fire. The Massachusetts Division of Environmental Health granted RSI permission to use the B&M land to dispose of its loose, burnt refuse. The waste disposed of by RSI on B&M land was classified as municipal and light industrial solid wastes from the cities of Cambridge and Somerville. There were no records kept on specific waste characteristics. By 1976, the area was no longer being used, and vegetative cover was returning.

Although soil samples from this area were not analyzed during the Phase 1A RI, samples of surface water and sediment were collected and analyzed from the unnamed brook, at the point where it discharges to an adjacent wetland area. In addition, groundwater samples were collected from a cluster of monitoring wells installed in the adjacent wetland area. Detectable levels of contaminants were not found in nearby surface waters, but detectable levels of VOCs were found in the bedrock well (27 ppb) and the shallow overburden well (6 ppb). A sediment sample collected from the adjacent wetland area contained PAHs (9 ppm) and elevated levels of arsenic (81 ppm) and lead (1,000 ppm).

1.2.5.3 Old B&M Oil/Sludge Recycling Area. The 6-acre, Old B&M Oil/Sludge Recycling Area was established sometime prior to 1938 for the purpose of recycling oil. A B&M Railroad site plan, dated 1972, shows two adjacent areas designated as "oil and sludge" which appear to be located about 300 feet west of the B&M locomotive shop repair facility (CDM, 1989a). These two areas, where the oil and sludge pooled, had a combined dimension of 600 by 200 feet. In 1973, the Penn Culvert Company purchased the parcel of land containing these two disposal areas and sometime later filled them in.

During a NUS Corporation site inspection and the CDM Phase 1A RI, subsurface soil samples were collected from these areas (CDM, 1989a). A summary of the analytical results is presented in Table 1-2. The results from both sampling rounds revealed that the soils are contaminated with lead (up to 27,000 ppm) and PAHs (0.5 ppm to 10 ppm) at depths ranging from the surface to 6 feet. In addition, both NUS and CDM observed that these soils were visibly contaminated with oil (CDM, 1989a).

1.2.5.4 The Contaminated Soil Area. The Contaminated Soil Area is located in the center of the Iron Horse Industrial Park and is approximately 50 acres in size. The Contaminated Soil area contains properties owned by George McQuesten, Wood Fabricators, and the MBTA (Figure 1-3). The area is bounded on the east by the B&M Landfill, the RSI Landfill, and an unnamed brook, on the west by the Asbestos Lagoons and property owned by George McQuesten, on the south by the Old B&M Oil Sludge Area and the B&M Locomotive Shop, and on the north by property owned by the MBTA.

Contaminated soil was first identified as a problem in the central portion of the Iron Horse Industrial Park after a random soil boring program conducted across the Site indicated elevated levels of lead (310 to 76,600 ppm) at nine out of forty locations. The results for locations where lead levels exceeded expected background levels (300 ppm; CDM, 1987; 1989a) are presented in Table 1-3.

In particular, there are two locations on B&M property where lead concentrations were present at high levels. The extent of contaminated soil was investigated based on the findings of the random soil boring program.

1.2.5.5 Asbestos Contamination. Asbestos contamination associated with the Asbestos Landfill and Asbestos Lagoons are described in the following sections.

Asbestos Landfill. The Site has historically been identified with asbestos contamination due to asbestos landfilling operations conducted by Johns-Manville Mover a 32-year period. Although EPA capped the Asbestos Landfill in 1984, "asbestos contamination" was identified by CDM (1987) as a potential operable unit because the cap is not currently maintained. The integrity of the cap was evaluated as part of the RI. Asbestos materials have been found outside the limits of the cap, and the entire western boundary of the cap is not fenced.

In 1985, during Phase 1A RI (CDM, 1987), surficial soils (0 to 3 inches) from 40 random boring locations were also analyzed for the presence of asbestos. Asbestos was detected at 28 of the locations sampled and, at 8 of these, located on Johns-Manville (currently BNZ Materials), Penn Culvert, and B&M properties, asbestos was present at levels greater than 1%. This suggested that wind-blown deposition of asbestos (CDM, 1989) had occurred in portions of the Site on B&M property adjacent to the landfill, as well as on Johns-Manville (currently BNZ Materials) property where the asbestos waste originated.

An off-site soil sampling program (CDM, 1988) was also conducted to determine the extent, if any, of wind-blown deposition of asbestos in residential areas bordering the Site. The results of the off-site soil sampling indicated that, with one exception, there were no detectable levels of asbestos in these residential areas. Therefore, CDM's Draft Phase 1A RI report (1989a), concluded that deposition of wind-blown asbestos from the Site to off-site areas most likely did not occur.

The Asbestos Landfill Cap Evaluation Report (M&E, 1994c) was submitted to EPA in February 1994. This report documents the recent evaluation of current surficial conditions of the landfill and recommends corrective actions to be implemented to protect public health and comply with state and federal regulations.

Asbestos Lagoons. In addition to the Asbestos Landfill, there are three unlined asbestos lagoons on Johns-Manville (currently BNZ Materials) property. One of these lagoons has been filled and covered. When the lagoons were operated by Johns-Manville, they received an asbestos slurry pumped from the adjacent manufacturing operations. Asbestos from these lagoons was disposed of in the asbestos landfill; however, the lagoons allegedly still contain some asbestos.

The lagoons continued to receive wastewater from Johns-Manville operations after asbestos manufacturing operations closed. While this discharge did not contain asbestos, it may have contained some other hazardous substances (CDM, 1989a).

1.2.5.6 PCB Contamination. In 1985, during the Phase 1A RI, PCBs were discovered in the Johns-Manville storm drain system, which discharges to the Middlesex Canal. Sediments from two of the catch basins in that system, as well as sediments from the Middlesex Canal, were contaminated with PCBs at concentrations ranging from 10 to 270 ppm.

Following this discovery, Johns-Manville hired Goldberg, Zoino & Associates, Inc., (GZA) as a consultant to initiate an independent investigation to confirm and clean out the contamination from its storm drain system. As part of the investigation, GZA conducted three separate sampling events. In March 1986, sediment samples were collected from six catch basins/manholes during a dredging operation conducted by a hazardous waste contractor through GZA. In April 1986, samples were collected from eight locations along the Middlesex Canal. In May 1986, soil samples were collected from six locations adjacent to the six catch basins/manholes. During these three events, CDM observed and collected split samples for independent analyses. In July and September 1986, GZA performed two additional sampling rounds on the Johns-Manville storm drain system during which neither EPA nor CDM personnel were present. A few months later, Johns-Manville informed EPA that 20 feet of the storm drain discharge pipe to the Middlesex Canal were dug up and removed. Johns-Manville stated that the end of the pipe was sealed with a concrete plug and that the discharge system was no longer in service. All sampling locations are presented in Figure 4-4 of the Phase 1A RI report (CDM, 1987).

The results of the additional sampling conducted by GZA confirmed the presence of PCBs in Middlesex Canal sediments near the discharge pipe and confirmed the presence of PCBs in two additional manholes that were part of the system. The results of soil sampling conducted adjacent to the old catch basins revealed PCB concentrations in soils ranging from 1.5 to 20 ppm (CDM,1987).

The Middlesex Canal was sampled by CDM in six locations both upgradient and downgradient of a discharge pipe that entered the Middlesex Canal north of the Asbestos Lagoons; no detectable levels of PCBs were found. It appeared that no migration of PCBs occurred from this discharge point. These PCB data from previous investigations were evaluated as part of the RI.

During February 1994, the PCB Contamination Evaluation Report (M&E, 1994b) was submitted to EPA. This report compiled and evaluated all available data and subsequent remedial recommendations presented in the Phase 1A RI report (CDM, 1987) and the PCB Investigation Report (GZA, 1987) to develop a full understanding of the potential contamination that may exist in the area of the Site. Recommendations of corrective actions to be implemented to protect public health were provided.

1.2.5.7 Groundwater. During CDM's Phase 1A, 1B, and 1C RIs, elevated concentrations of VOCs were detected in groundwater east of the Shaffer landfill and were also measured at lower concentrations in groundwater north, west, and northwest of the landfill (CDM, 1987; 1988; and 1989b). Semivolatile organic compounds (SVOCs) were found in groundwater downgradient and southeast of the landfill along Gray Street. In areas north and upgradient of the landfill, metals were found in groundwater at elevated concentrations (CDM, 1987; 1988; and 1989b). Results of the Phase 1A RI data were summarized in the Hydrogeological Report (M&E, 1994a).

1.2.5.8 Site-Wide Surface Water and Sediment. Surface water samples were collected across the Site during the Phase 1A and 1C RIs (CDM, 1987 and 1989b). The highest VOC concentrations were generally found to the north of the Shaffer landfill, on the southern edge of Richardson's Pond, and along Content Brook. The Ambient Water Quality Criteria were exceeded for arsenic in all samples (CDM, 1989b).

Sediment samples were collected across the Site during the Phase 1A and 1C RIs (CDM, 1987 and 1989b). Volatile organic compound concentrations were highest along the northern edge of the Shaffer landfill and the southern edge of Richardson's Pond. Semivolatile organic compounds were found both upstream and downstream of the landfill. Low levels of pesticides were also detected in the vicinity of the landfill.

1.3 REMEDIAL INVESTIGATION OBJECTIVES

The overall goals of the RI/FS are to:

- Complete a field program for collecting data to quantify the extent and magnitude of contamination in different environmental media within the site
- Determine the public health and ecological risks associated with existing contamination at the Site
- Develop and evaluate remedial alternatives, if unacceptable risks are identified

The primary objectives of the RI are to:

- Define source(s) and evaluate nature, extent, and distribution of contaminants detected at the Site
- Further characterize contaminant transport pathways
- Evaluate and quantify potential exposure pathways
- Assess contaminant risks to public health, ecology, and the environment

1.4 REPORT ORGANIZATION

A description of the field investigations and the results of this RI are presented in the following sections of this report:

- Section 2.0, Site Investigation, presents the field investigations performed, the field and laboratory methodologies used, and the sampling locations
- Section 3.0, Site Characteristics, presents results of the geologic, hydrogeologic, and ecologic investigations
- Section 4.0, Nature and Extent of Contamination, presents the analytical results for the surface and subsurface soil, groundwater, surface water, and sediment samples collected
- Section 5.0, Contaminant Fate and Transport, discusses the fate and transport of detected contaminants within the environmental setting of the Site
- Section 6.0, Human Health Risk Assessment, evaluates the human health risks associated with the Site
- Section 7.0, Ecological Risk Assessment, evaluates the ecological risks associated with the Site
- Section 8.0, Summary, Conclusions, and Recommendations, summarizes the report findings and describes conclusions of the investigation

The report is divided into five volumes. Volume one contains the text. Volume two contains the tables, and volume three contains the figures referred to in the text. Volumes four and five contain Appendices A through I.

SECTION 2.0

SITE INVESTIGATION OVERVIEW AND TECHNICAL APPROACH

The purpose of the RI field investigation was to collect data to further characterize the Site in terms of geology, hydrogeology, and hydrology; groundwater, surface water, sediment, and soil chemistry; and ecological resources in order to evaluate potential contamination and contaminant migration. The RI field investigation was conducted in accordance with the following M&E project documents:

- Metcalf and Eddy, Inc. (M&E). 1993a. *Final work plan for remedial investigation - Iron Horse Park Superfund Site, 3rd. Operable Unit, North Billerica, MA*

- Metcalf and Eddy, Inc. (M&E). 1993b. *Final field sampling plan for remedial investigation - Iron Horse Park Superfund Site, 3rd. Operable Unit, North Billerica, MA.*

- Metcalf and Eddy, Inc. (M&E). 1993c. *Final quality assurance project plan for remedial investigation - Iron Horse Park Superfund Site, 3rd. Operable Unit, North Billerica, MA*

- Metcalf and Eddy, Inc. (M&E). 1993d. *Final health and safety plan for remedial investigation - Iron Horse Park Superfund Site, 3rd. Operable Unit, North Billerica, MA*

- Metcalf and Eddy, Inc. (M&E). 1994e. *Final work plan amendment for remedial investigation - Iron Horse Park Superfund Site, 3rd. Operable Unit, North Billerica, MA*

- Metcalf and Eddy, Inc. (M&E). 1994f. *Sampling and analysis plan addendum for remedial investigation - Iron Horse Park Superfund Site, 3rd. Operable Unit, North Billerica, MA*

- Metcalf and Eddy, Inc. (M&E). 1994g. *Site safety and health plan addendum for Remedial Investigation - Iron Horse Park Superfund Site, 3rd. Operable Unit, North Billerica, MA*

The RI field investigation was conducted from June through October 1993 and from October 1994 through August 1995. A chronology of the RI field investigation activities is presented in Table 2-1.

A summary of RI field activities conducted by area is presented in Table 2-2, and the rationale or purpose for each activity is described in Table 2-3.

A site reconnaissance was conducted early in the summer of 1993 to provide a preliminary survey of the Site. Field work performed during the reconnaissance included an ecological component (wetland inspection, habitat delineation, wildlife surveys, and benthic reconnaissance), establishment of a grid system, the location and collection of current information on existing wells and piezometers, water level measurements, evaluation of the asbestos landfill cap, and identification of surface water and sediment sampling locations.

Following the site reconnaissance, a series of additional field investigation activities were conducted during the summer and fall of 1993. Soil borings and test pits were advanced, and subsurface soil was sampled. Surface soils and groundwater were sampled. Two rounds of surface water and sediment sampling were also conducted, the first in late spring and the second in late fall 1993.

The final phase of the RI field investigation was conducted from October 1994 through August 1995. The field activities that occurred during this period consisted of the installation of piezometers and monitoring wells, aquifer testing, additional water level measurements, and groundwater sampling. Two rounds of groundwater sampling were performed, the first in the spring and the second in the summer of 1995. An additional geophysical survey was also conducted.

The objectives and rationale for performing different activities during the field investigation (Table 2-3) are more fully detailed in the Final Work Plan (M&E, 1993a) and the Final Work Plan Amendment (M&E, 1994e). The Final Field Sampling Plan (M&E, 1993b) and the Sampling and Analysis Plan Addendum (M&E, 1994f) describe the methodologies and procedures that were generally followed during the various field activities. Elements of the RI field investigation, including methodologies and site reconnaissance results, are further discussed in the following sections.

2.1 FIELD METHODOLOGIES

The activities that were conducted based on the Final Work Plan (M&E, 1993a) include:

- Site reconnaissance
- Staff gauge installation
- Surface geophysical surveys
- Test pit excavation and sampling
- Soil boring advancement and sampling
- Surface soil sampling
- Surface water and sediment sampling
- Groundwater screening

The information gathered during the above-stated activities was used in conjunction with data collected during previous studies to develop a field program to evaluate the nature and extent of contamination emanating from five of the nine areas of concern including: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, and the Asbestos Lagoons. The Hydrogeological Assessment Report (M&E, 1994a) provided the interpretive evaluation of geologic and hydrogeologic field data collected to-date, and also served as the basis for the additional field investigation activities conducted in 1994 and 1995 at these five areas of concern. The activities that were conducted based on the Final Work Plan Amendment (M&E, 1994e) include:

- Additional surface geophysical surveys
- Piezometer installation
- Monitoring well installation
- Seepage meter installation
- Additional staff gauge installation
- Water level measurements
- Groundwater sampling

- Aquifer testing

The following sections summarize the field methodologies for non-sampling activities; sampling activities are discussed in section 2.2.

2.1.1 Site Reconnaissance

As described above, the RI field investigation began with the reconnaissance of the Site, which included the following activities:

- Site mobilization
- Ecological characterization
  - Habitat delineation
  - Wetland inspection
  - Wildlife survey
  - Benthic reconnaissance
- Establishment of grid systems
- Preliminary hydrogeologic assessment
  - Existing well and piezometer inventory
  - Staff gauge installation
  - Water level measurements
- Evaluation of asbestos landfill cap
- Surface water and sediment sampling location reconnaissance

2.1.1.1 Site Mobilization. Mobilization of the field support and drum storage areas began in early May 1993 and was completed by the beginning of June 1993. These areas were located in the southeastern portion of the Site, directly off Pond Street, as shown in Figure 2-1.

Mobilization activities included the placement of gravel in, and the installation of fences around, each area; delivery and setup of the storage, office, and decontamination trailers; and provision of telephone and water service and electrical power to the field support area. Potable water was obtained from the town of Billerica through the town's water supply.

2.1.1.2 Ecological Characterization. This section summarizes the methodology used during ecological surveys conducted at the Site between May 1993 and November 1994. Results of the wetland and wildlife investigations have been reported in M&E's Ecological Characterization for Remedial Investigation (1995), which is presented in Appendix A. Field surveys were conducted on May 10 and 12, 1993, on July 15, 1993, and on November 8, 1994. The field investigations included a wetland delineation/inspection and habitat description, wildlife observations, aquatic resources reconnaissance, and investigations of ecological resources in nearby and downstream areas that could potentially be affected by migrating contaminants or future remedial actions. These studies were intended to supplement previous studies conducted on the Site (Weston, 1989). The objectives of the surveys were to:

- Assess the general use of the Site by biological resources, particularly mammals, birds, reptiles, amphibians, and stream benthos
- Identify any overt effects of contamination and identify potential ecological pathways for site contaminants
- Confirm the location and extent of ecological resources in the Site, such as wetlands and surface water bodies, that could serve as important wildlife habitat or perform other ecological functions
- Identify the characteristics and qualitatively evaluate the function of wetlands for use in considering potential remediation and site restoration/mitigation decisions

Wetland Delineation/Inspection. Wetland delineation was accomplished in the eastern portion of the Site (Shaffer Landfill) using both off-site and on-site determination methods (M&E, 1993e). In the western portion of the Site (west of Pond Street), a wetland inspection was conducted to confirm the type and areal extent of wetlands present. Since the wetland delineation for Shaffer Landfill has been described in a previous report (M&E, 1993e), only the methodology and results from the wetland inspection in the western portion of the Site are described in this report.

Wetland areas of the Site were previously identified in the fall of 1987 (Weston, 1989). The results of this evaluation were verified during field wetland inspections on July 15, 1993 and November 8, 1994, to determine if the approximate areal extent, the type, and/or the plant species composition of the wetland areas had changed significantly. During these inspections, wetland areas were field mapped (using USFWS wetland classifications from Cowardin et al., 1979) and photographed, species and percent dominance of wetland plants were determined, observations of rare wetland species were noted, and any overt signs of stress (such as dead or dying vegetation) were recorded. Information necessary to determine the functions and values of the existing wetlands was also collected. The functional assessment included the evaluation of the occurrence of each of 13 different functions and assessment of the principal valuable function in each of the nine wetland areas originally identified by Weston (1989), plus two additional areas (Wetland 10 which is located east of High Street and Wetland 11 which is located south of the B&M Railroad tracks and southwest of Wetland 1) shown in Figure 2-2. The results of the assessment are reported in M&E's Ecological Characterization for Remedial Investigation (1995).

Habitat Mapping. General habitat types were mapped using low-altitude color aerial photographs taken in March, 1988 and field notes obtained during the reconnaissance surveys conducted by M&E in July 1993 and November 1994. The resulting habitat map was combined with the wetland site plan (described below), using a geographical information system (section 2.5), to determine acreage of individual habitat types. Wetland habitat types followed the classification system of Cowardin et al. (1979), and upland habitat classifications were adapted from Reschke (1987).

Wildlife Surveys. A reconnaissance-level wildlife survey of the eastern portion of the Site (east of Pond Street) was conducted on May 10 and 12, 1993, as part of the wetland delineation at Shaffer Landfill. On July 15, 1993, a similar reconnaissance-level survey was conducted on the western portion of the Site (west of Pond Street), concurrent with the wetland inspection. Additional observations were made during the November 1994 wetland field work. The surveys concentrated on important wildlife habitats, such as vegetated wetland and open water areas, with less emphasis given to highly disturbed habitats such as buildings and rail yards. The results of this survey were used to supplement limited information previously collected in the fall of 1987 (Weston, 1989) and to support the ecological risk assessment.

During these surveys, M&E biologists noted all observations of birds, mammals, reptiles, and amphibians or their sign, mainly tracks or scat. Observations of feeding activity, nesting activity, or the presence of young were also noted. Any sightings of animal carcasses or unusual behavior were also recorded as well.

Benthic Reconnaissance. Qualitative benthic macroinvertebrate surveys were conducted on October 6 and 7, 1993, at 24 locations in surface water bodies present at the Site (Figure 2-2) to supplement results from previous quantitative benthic macroinvertebrate sampling. All major on-site water bodies (Middlesex Canal, unnamed brook, Content Brook, and Richardson Pond) were sampled. Sampling locations were selected in consultation with EPA during the surface water and sediment sampling location reconnaissance (section 2.1.1.6). Where feasible, benthic sampling locations were located at surface water and sediment locations sampled by M&E in June and September 1993 (section 2.2.3). Of the 24 benthic invertebrate sampling locations, five (RS-01, RS-02, MC-01, RW-01, and RP-04) were located away from known sources of on-site contamination and were considered "reference" locations.

Sampling methodology generally followed procedures described in Plafkin et al. (1989). Lotic (flowing water) habitats were sampled using a kick net and/or a dip net. In lotic areas with measurable flow, a 9-m^2 area was sampled with a kick net by agitating the bottom substrates and catching the displaced sediments and organisms in the net. If water flow was minimal or large amounts of aquatic vegetation were present, sampling was conducted using a dip net, which was swept along the bottom sediments (digging into the top 2 centimeters of sediments) or vegetation over a 9-m^2 area. If emergent vegetation was also present at a lotic sampling location, a 3-m^2 area of emergent vegetation along the bank was swept with a dip net. The resulting material from the kick or dip net sample was combined with the emergent vegetation dip net sample in a No. 30 sieve bucket, and the combined sample was then sieved to remove fine sediments. Due to time constraints, organisms were not identified in the field (other than to note major taxa present).

Instead, samples of organisms and vegetation were placed in polyethylene bottles (after removing large rocks, sticks, and other debris) and preserved with a 70% ethanol solution for later identification. Since the substrates at most sampling locations contained large amounts of detritus and the habitats present at each station were relatively uniform, separate coarse particulate organic matter (CPOM) samples were not collected.

Initially, lentic (standing water) habitats were sampled with a 15.25-centimeter (6-inch) Eckman dredge, which sampled a surface area of 230 cm^2. Since water depths in on-site lentic water bodies were very shallow at the time of the survey, the dredge was attached to a stick, pushed into the sediments, and tripped by a biologist wearing chest waders. Care was taken to avoid disturbing the sediments at the sampling point prior to the collection of the sample. Two lentic samples were collected at each station with the dredge and composited in a No. 30 sieve bucket. The composite sample was then sieved and sorted in the field.

Since samples at the two reference stations placed in lentic habitats (RW-01 and RP-04) contained few or no benthic invertebrates, no further samples were collected using the Eckman dredge. Instead, dip net samples were collected and processed at the two lentic reference locations, as well as at all on-site lentic locations, as described above for lotic habitats. This methodology was employed because the larger area sampled (9 m^2) with the dip net facilitated collection of an increased number (and thus a more representative sample) of invertebrates.

Prior to the collection of each benthic invertebrate sample in lotic and lentic habitats, field parameters consisting of temperature, conductivity, pH, and dissolved oxygen were measured in situ using a Surveyor II Hydrolab. During sample collection, water depth was measured to the nearest centimeter using a meter stick. Flow rates were visually estimated using the following categories:

(1) None, no visible flow
(2) Minimal, directional flow evident, but too slow to measure
(3) Low, less than 0.3 m/s
(4) Moderate, 0.3 to 1 m/s

(5) High, more than 1 m/s

Sediment descriptions were compiled, and structural habitat features [using five of the variables defined in Plafkin et al. (1989)] are presented in Table 2 of M&E's Ecological Characterization Report (1995).

Following review, the values obtained for these field parameters were considered unreliable because of meter problems in the field, and the data were not used. However, these parameters were also measured during sampling at associated surface water and sediment locations (sections 2.2.3 and 2.2.4), which was conducted approximately two weeks prior to the benthic surveys. Although absolute values for some field parameters (particularly temperature and dissolved oxygen, which is dependent on temperature) might have varied within this two-week period, it is assumed that the variances between measurement periods would be minor. Thus, the field parameter data collected during the June surface water and sediment sampling are considered representative for a qualitative evaluation.

Following the field survey, samples were sieved using a No. 30 sieve bucket and sorted; benthic macroinvertebrates present were identified and enumerated. Tadpoles and small fish, if present, were also enumerated. Consistent with the procedures of Rapid Bioassessment Protocol I, taxonomic identification of benthic invertebrates was generally conducted only to the level of order or family, and the number of organisms of abundant taxa (greater than 50 organisms) was estimated rather than counted. Data were evaluated by comparing the presence of pollution sensitive taxa (the orders Ephemeroptera, Plecoptera, and Tricoptera (EPT), and Amphipoda) and pollution-tolerant taxa (the family Chironomidae) between reference and on-site sampling locations.

2.1.1.3 Establishment of Grid System. Prior to initiating any field investigation activities, a reference grid was established parallel to magnetic north in the following areas: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, the Asbestos Lagoons, and the Johns-Manville Asbestos Landfill. The grid in each area was set up initially on 100-foot centers with north-south lines named using letters and east-west lines using numbers. Grid coordinates reported in Appendix B observe this notation. To facilitate the geophysical survey, the grids were further subdivided by additional north-south lines every 25 feet. Figure 2-3 shows the grid layout for each of the above areas. To accommodate the additional geophysical surveys that were conducted in 1994, the reference grid in the Old B&M Oil/Sludge Recycling Area was further expanded as shown in Figure 2-3. The grid system was established relative to the Massachusetts State Plane Coordinate System, as discussed in sections 2.4 and 2.5.

2.1.1.4 Hydrogeologic Assessment. A preliminary hydrogeologic assessment was undertaken during the site reconnaissance to collect data to be used in conjunction with data collected from geophysical surveys (section 2.1.2) and test pit and soil boring investigations (sections 2.1.3 and 2.1.4) for developing a field program to further evaluate groundwater contamination. Field activities conducted during the site reconnaissance in support of the hydrogeologic assessment included an inventory of existing monitoring wells and piezometers, the installation of staff gauges, and two rounds of synchronous groundwater and surface water level elevation measurements, as described in the following sections. Additional hydrogeologic assessment field activities are also presented for field work that was conducted in conjunction with the Final Work Plan Amendment (M&E, 1994b).

Existing Well and Piezometer Inventory. An inventory was undertaken from July 13 to 16, 1993, to locate and assess the condition of the 53 OW-series monitoring wells and the 19 P-series piezometers that were installed across the Site during previous studies. Although all of the previously installed monitoring wells were found, only 10 of the P-series piezometers were located. The total depth of the well, depth to water, and organic vapor levels in the headspace were measured at each monitoring well and piezometer. For each monitoring well, the security, the condition of the outer steel casing and PVC casing, and the condition of the concrete pad were noted. The condition of the PVC casing of each piezometer was also noted. Figure 2-4 shows the OW-series monitoring wells and P-series piezometers that were located. The information collected from the monitoring well and piezometer inventory is summarized in Table 2-4.

Staff Gauge Installation. On July 15 and 16, 1993, staff gauges were installed at nine locations across the Site (SG-1 through SG-9). Staff gauges were later installed at five other locations (SG-10 through SG-14) in March 1995, as discussed below. The staff gauges were located in surface water bodies to evaluate the relationship between groundwater and surface water, particularly near potential source areas. Staff gauge locations are shown in Figure 2-5. The staff gauges were constructed using heavy-gauge steel fence posts driven 2 to 3 feet into the sediment. The tops and locations of the fence posts were surveyed as described in section 2.4.

Water Level Measurements. Groundwater elevations in existing piezometers and OW-series monitoring wells, and surface water elevations at the nine staff gauges, were measured synchronously on September 13 and December 8, 1993. September measurements were obtained one day before the second round of surface water and sediment sampling commenced, which corresponded to a period of low flow (section 2.2.3), to evaluate water-level effects on chemical and physical conditions.

During each measuring round, all of the groundwater elevations were measured within an 8-hour period using electronic water level indicators. The depth to water was measured to a notch in the PVC casing at which the casing elevation had been surveyed (section 2.4). Surface water elevations were measured at the staff gauge locations by measuring the depth from the top of the stake to the water surface.

Additional Hydrogeologic Data Collection. In 1994 and 1995, additional field work was conducted to supplement data collected in 1993. Although the additional work was undertaken as part of the RI field investigation specified in the Final Work Plan Amendment (M&E, 1994e), it is incorporated here to facilitate discussion of the hydrogeologic field work. This field work included the installation of additional staff gauges as well as the installation of seepage meters at some of the additional and existing staff gauge locations. Three additional rounds of water elevation level measurements were also conducted. Groundwater elevations were measured in the existing OW-series monitoring wells and piezometers and in new monitoring wells and piezometers (sections

2.1.5 and 2.1.6). Surface water elevations were obtained from the staff gauge locations, and stream-bed conductivity and vertical hydraulic gradient data were collected at the seepage meter locations.

Staff Gauge Installation. Staff gauges were installed on March 30, 1995, at five additional locations (SG-10 through SG-14), which are shown in Figure 2-5. These staff gauges were installed to provide additional information about surface water and groundwater interactions. The additional staff gauges were constructed and installed in the manner previously described.

Seepage Meter Installation. Seepage meters were installed on March 30, 1995, at nine locations (Figure 2-5) to verify and quantify the interaction between groundwater and surface water so that the potential for discharge of contaminated groundwater from the areas of concern could be evaluated. The seepage meters were constructed using 30-gallon galvanized steel tubs or heavy duty plastic 50-gallon garbage cans depending on the pre-measured depth of the surface water body. A hose barb was installed with an airtight seal through the bottom of the tub or garbage can, and plastic tubing was connected to the end of the hose barb. The seepage meters were installed by inverting the tub or garbage can and pushing the top approximately 1 foot into the sediment at the bottom of the surface water body.

A 1½-inch-diameter stream-bed piezometer was installed adjacent to each seepage meter to determine the vertical hydraulic gradient between groundwater and surface water at each of the nine locations. The piezometers consisted of a steel (Johnson "Red Head") drive point and steel riser pipe. The piezometers were driven approximately 2 feet into the sediment at each location.

The potential for groundwater discharge at the seepage meters was measured by attaching a weighted plastic bag to the end of the plastic tubing and measuring the rate of flow into the bag. Stream-bed hydraulic conductivities and the potential for groundwater discharge were determined from the measurements. The rate of groundwater discharge was measured during the April 1995 water level measurement round (described below) at each seepage meter location.

Water Level Measurements. On December 14, 1994, a preliminary round of synchronous water level elevations were measured in the existing OW-series wells and piezometers, the newly-installed piezometers (section 2.1.5), and the nine staff gauge locations. The water elevation data from the preliminary round was used to assess shallow groundwater flow directions prior to locating the new monitoring wells to be installed as part of the RI field investigation (section 2.1.6). Two additional rounds of water level elevation measurements were made on April 12 and August 1, 1995, each following the completion of a groundwater sampling round. The April measurements were obtained from all of the existing and newly installed monitoring wells and piezometers and nine staff gauges. The August measurements included all of the existing and newly installed monitoring wells and piezometers, 14 staff gauges, and all of the seepage meters. During the two water level rounds, groundwater and surface water elevation levels and seepage meters were measured as described above.

2.1.1.5 Evaluation of Asbestos Landfill Cap. An initial walkover reconnaissance of the Johns-Manville Asbestos Landfill and surrounding area was conducted on October 25, 1993. On December 12, 1993, a follow-up inspection was performed to verify and refine observations made during the initial walkover. The reconnaissance consisted of a systematic walkover of the cap. Prior to the walkover, a grid system was established and staked at 100-foot intervals over the visually observed limits of the landfill (section 2.1.1.5 and Figure 2-3). Field observations were tied into the grid system. The reconnaissance focused on visual inspection of topsoil and vegetative cover on the landfill cap. The absence of topsoil and vegetation, general types of vegetation, and exposed cap or waste materials were noted. Surface water drainage patterns across the cap as well as slope conditions and eroded areas were recorded. Cap maintenance and access issues were also documented. The inspection did not include soil or waste sampling, analytical investigation of the cap, or air monitoring for asbestos. The results of the site inspections are discussed in M&E's Asbestos Landfill Cap Evaluation Report (1994c), which is included in Appendix A of this report. The report also discusses recommendations for potential corrective actions.

2.1.1.6 Surface Water and Sediment Sampling Location Reconnaissance. On May 27 and 28, 1993, M&E, EPA, and the MADEP personnel located 46 surface water and 47 sediment sampling locations that were to be sampled as part of the RI field investigation (sections 2.2.3 and 2.2.4). Of these sampling locations, 24 are historic locations. In addition to these historical locations, 22 new surface water and 23 new sediment locations were identified. The new locations, situated along the southwestern shore of Richardson Pond and between the lobes of the Shaffer Landfill, largely correspond to areas of past or present seepage that were visible in aerial photographs. In addition, five extra sediment sample locations were added, one near a former salt/sand pile and four in the Asbestos Lagoons area, making a total of 28 new sediment sampling locations. The surface water and sediment sampling locations that were sampled during the RI field investigation are shown in Figure 2-6.

2.1.2 Surface Geophysical Surveys

Surface geophysical surveys were conducted in four of the areas of concern: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas, and the Old B&M Oil/Sludge Recycling Area. Two surface geophysical techniques, electromagnetic induction or terrain conductivity (EM) and ground penetrating radar (GPR), were used in each area in an attempt to delineate the horizontal extent of waste disposal and identify potential sources of contamination such as buried drums. Each of these methods, and the manner in which they were conducted in each area, is discussed in the following sections. The surveys were generally conducted within the reference grid (Figure 2-3), but in some areas the surveys were extended outside the grid based on in-field findings. All surface geophysical surveys were conducted by Hager-Richter Geoscience, Inc., of Salem, New Hampshire, under subcontract to M&E. Additional EM surveys were conducted in 1994 in the Old B&M Oil/Sludge Recycling Area. Copies of the two reports describing the methods and findings of the geophysical investigation are presented in Appendix C.

2.1.2.1 Terrain Conductivity. The EM method measures apparent electrical conductivities of subsurface materials, which in turn can be characterized by their electrical properties. Lateral changes in conductivity values generally indicate a variation in subsurface conditions. The relative terrain conductivity of earth materials is particularly sensitive to water content and dissolved ions or salts.

Terrain conductivity surveys using a Geonics EM31-DL were conducted in each of the areas using M&E's reference grid. In each area, terrain conductivity data for both quadrature-phase (apparent terrain conductivity) and in-phase components were recorded at 10-foot intervals along north-south trending lines spaced 25 feet apart. The instrument was operated in the horizontal dipole mode (nominal depth of exploration about 9 feet) in the Old B&M Oil/Sludge Recycling Area and in the vertical dipole mode (nominal depth of exploration about 18 feet) in the other three areas of concern. Instrumental drift was within the manufacturer's specifications and background for the Site was established at 10 mmho/m, using background transects in each of the survey areas.

2.1.2.2 Ground Penetrating Radar. The GPR technique involves the use of high frequency radio waves, which are propagated into the subsurface and reflected back to a receiving antenna. Variations in the return signal are caused by radar wave reflections from subsurface materials having different electrical properties. These reflections are associated with geological characteristics such as bedding, cementation, moisture, lithology and structure, as well as man-made features (Benson et al., 1982).

Locations for GPR data collection in each area were selected on the basis of preliminary plots of EM data. The spacing between and the lengths of the GPR transects were specific to the area being investigated. Reconnaissance transects and GPR lines were run to verify EM data that suggested the horizontal extent of disposal areas. In addition, in-phase EM anomalies, which suggested the presence of buried metal, were also further investigated using GPR .

2.1.2.3 Geophysical Survey Results. This section describes the surface geophysical surveys conducted in each of the four areas of concern. Results and methods of survey are presented in Appendix C as part of the Final Geophysical Reports (H-R, 1993 and 1996). The survey results that are briefly discussed below, served as the basis for locating test pits and soil borings, which are respectively described in sections 2.1.3 and 2.1.4. Section 3.2.2.3 discusses in more detail the results of geophysical surveys by area of concern.

B&M Railroad Landfill. To determine the disposal limits of the landfill and to locate buried metallic objects, terrain conductivity surveys were conducted across the landfill as well as beyond the expected limits of the landfill. Data from 2,089 EM data stations were collected. Twenty-two GPR transects totaling 2,965 linear feet were run to investigate or verify EM anomalies.

The pattern of quadrature-phase and in-phase EM anomalies detected in the landfill indicate that refuse extends to the edges of the area surveyed. Only along the northern fringes of the survey area did values of apparent terrain conductivity approach the nominal background values measured off-site, delineating the northwestern boundary of the landfill. The EM data indicated six areas with relatively high concentrations of metallic objects and one area in the northwest corner of the landfill with a high amplitude terrain conductivity anomaly.

The GPR transects were concentrated in the northwest corner of the landfill where EM data suggested a flat object such as a concrete slab. The GPR data were characterized by high-amplitude, ringing reflections typically caused by metallic objects. Test pits excavated in the area revealed what appeared to be a buried parking lot or gravel road surface. Four reconnaissance GPR traverses of the interior of the B&M Railroad Landfill were characterized by discontinuous, irregular reflections typical of landfill materials.

RSI Landfill. EM data was collected across the landfill and beyond the expected limits of the landfill to define its boundaries and locate buried metallic debris. Measurements were taken from 1,729 EM data stations. Thirteen GPR transects totaling 2,250 linear feet were conducted to investigate or verify EM anomalies.

Terrain conductivity data collected in the RSI Landfill suggest that the disposal area is located in the central portion of the survey area. The EM data also indicate that refuse in the landfill is rich in metallic objects. The GPR transects delineated possible locations of buried metal objects.

B&M Locomotive Shop Disposal Areas. In both Areas A and B, EM data were collected across suspected filled areas as well as beyond the expected limits of the filled areas to define the fill boundaries. Data were measured from 161 EM data stations in Area A and from 654 EM data stations in Area B. All EM quadrature-phase and in-phase data from Area A exhibited similar patterns of scattered anomalies that were verified by the existence of visible surface metal debris. Because the anomalies can be attributed to the surface metal debris, GPR surveys were not conducted in Area A.

Twenty-two GPR transects were conducted in Area B totaling 2,100 linear feet. These transects were focused in areas of EM anomalies that did not correlate with surface metal debris and did not produce anomalies of the in-phase component. The EM data indicate two possible disposal areas in Area B. Contrasts between quadrature-phase and in-phase EM data suggest that the fill materials in Area B are primarily non-metallic. The GPR data indicate that scattered larger objects, some of which produced signatures typical of metal objects, were present within the primarily non-metallic fill.

Old B&M Oil/Sludge Recycling Area. EM surveys were conducted across the designated survey area, which consisted of an area behind the Penn Culvert building extending to the fenced boundaries of the Penn Culvert property. Data from 1,161 EM data stations were measured to delineate the horizontal extent of buried oil or sludge. A total of 33 GPR transects totaling 1,660 linear feet were conducted to investigate several EM anomalies.

Apparent terrain conductivity data contours indicate that several well defined zones with distinctly elevated values (greater than 30 mmho/m) are present in the survey area. When compared with the in-phase component, the data indicate that only a few of the EM anomalies are attributable to metal objects. Because EM anomalies detected along the northwest and southeast edges of the survey area correlated with areas of visibly stained ground, the non-metallic anomalies across the survey area were interpreted as locations of buried oil sludge. Based on the EM data, four separate areas of suspected oil/sludge disposal were identified. The horizontal extent of two of the areas appeared to extend outside of the survey area. GPR transects verified the EM data and suggested the presence of a flat buried metal object in the survey area.

To delineate the anomalies that extended beyond the boundaries of the original survey area, additional EM surveys were conducted in accordance with field investigation activities stated in the Final Work Plan Amendment (M&E, 1994e). The original survey area was bounded by the chain link fence that surrounds the Penn Culvert property. To accommodate the additional geophysical surveys, the reference grid in the area was further expanded north to the railroad bed and south to the B&M office building (Figure 2-3). The additional surveys were performed by Hager-Richter on December 7 and 8, 1994.

The additional EM surveys were conducted in the same manner as the previous EM surveys including use of the same equipment, a Geonics EM-31. A 50-foot line outside the survey area, which was used during the previous EM survey, was used to establish an estimated background terrain conductivity (10 mmho/m) for the Site. Background data were collected several times daily.

The EM data were collected using the EM-31, with station measurements recorded every 10 feet. The EM-31 was operated in the horizontal dipole mode to obtain a maximum penetration depth of approximately 9 feet (terrain conductivity data were obtained in the in-phase and the quadrature phase).

To correlate the 1993 EM data with the 1994 data, repeat measurements were taken from 150 EM stations that were included in the previous survey grid. Some differences were noted, which Hager-Richter attributed to seasonal variations such as air temperature and water table fluctuations. The 1994 data were corrected using a linear regression "best fit" approach.

The results of the combined data from the 1993 and 1994 EM surveys are shown in the Terrain Conductivity Survey, B&M Oil/Sludge Recycling Area (H-R, 1996), which is presented in Appendix C, which is an interpretation of apparent conductivity data, delineating the limits of the oil/sludge disposal areas using the 30-mmho/m contour as an indicator. The apparent conductivity data were compared with in-phase component data to determine the potential location of buried metal objects. Anomalous zones of elevated apparent conductivity in the northwest and southeast portions of the survey area correlate with areas of visibly stained ground.

The extent of the northwestern anomaly, which probably indicates buried oil/sludge in this portion of the area, was delineated with the additional EM surveys. The southeastern anomaly was, however, not fully delineated by the additional EM survey, which suggests that buried oil/sludge extends under the building on the Penn Culvert property, a building on the B&M Railroad property, and the railroad tracks.

2.1.3 Test Pit Excavations

A total of 27 test pits were excavated from August 16 to 24, 1993, to investigate geophysical anomalies detected during surface geophysical surveys. The test pits were located in the four areas of concern in which geophysical surveys were conducted: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas, and the Old B&M Oil/Sludge Recycling Area. The test pit locations are shown by area in Figures 2-7 through 2-10.

Test pits were excavated using a backhoe with a reach of approximately 12 feet. The average depth of the test pits was approximately 10 feet, depending upon the difficulty of the excavation and the types of materials encountered. Upon removal, the contents of the backhoe bucket were screened for organic vapors using a photoionization detector (PID). Analytical samples for chemical analysis were then collected as described in section 2.2.2.2. Upon completion, the excavated materials were backfilled into the test pit hole in approximately the same order that they were excavated.

The test pits were conducted under the supervision of, and logged by, an M&E geologist. Decontamination of the backhoe bucket was performed before and after each test pit was excavated and is described in section 2.1.9. Test pit logs are presented in Appendix D. Physical data recorded at each test pit location are summarized in Table 2-5.

The locations of test pits excavated in each of the four areas were chosen based on the results of geophysical surveys (section 2.1.2). The rationale for performing test pit excavations in each area is summarized below. The test pit results, described briefly below and further discussed in section 3.2.2.3, were used to develop the groundwater monitoring program described in the Final Work Plan Amendment (M&E, 1994e).

B&M Railroad Landfill. A total of 14 test pits were excavated in the B&M Landfill. Three test pit locations (TP-01, TP-02, and TP-03) were selected to investigate GPR anomalies in the northwest corner of the landfill. The GPR anomalies indicated the presence of a shallow flat reflector, which was interpreted as possibly metallic objects under a packed earth parking area. The remainder of the test pits (TP-04 to TP-14) were sited either along the edges of, or in the center of, large EM anomalies to investigate their sources.

During excavation of the 14 test pits, fill material such as wood, metal, deteriorated and empty drums, brick, and rubber was encountered. The thickness of fill as encountered in the test pits ranged from 0 to 13 feet.

RSI Landfill. The six test pits excavated in the RSI Landfill (TP-15 to TP-20) were all sited to investigate the presence of metallic objects suggested by GPR anomalies. In the RSI landfill, fill materials similar to those found in the B&M Railroad Landfill were encountered in all six test pits. Fill material (construction debris) was encountered from the ground surface to a depth of 12 feet.

B&M Locomotive Shop Disposal Areas. A total of four test pits were excavated in this area. One test pit, TP-24, was dug in Area A to investigate the presence of buried fill materials. Three test pits, TP-21 to TP-23, were excavated in Area B to investigate GPR anomalies that suggested buried metallic objects.

Fill material was not encountered in the test pit in Area A. Area B test pits encountered fill consisting of metal, rubber, wood, and brick. Metallic objects were encountered in each test pit that accounted for the GPR anomalies. The fill was observed as deep as 10 feet below the ground surface.

Old B&M Oil/Sludge Recycling Area. On September 14, 1993, three trench-like test pits, TP-25 to TP-27, were excavated in this area to verify EM anomalies that were indicative of oil and sludge deposits. Sand intermixed with free product or oily, stained sands was observed in each of the three test pits. Fill material was encountered from the surface to a maximum depth of 8 feet.

2.1.4 Soil Borings

A total of 46 soil borings were advanced throughout the Site to characterize and to investigate the horizontal and vertical extent of soil contamination. The soil borings were drilled from August 24 to September 3, 1993 in the four areas of concern in which geophysical surveys and test pits were conducted: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas, and the Old B&M Oil/Sludge Recycling Area. The boring locations are shown by area in Figures 2-7 through 2-10.

The soil borings were advanced by either a Mobil B-47 bombardier drilling rig or a Diedrich D-50 drilling rig, to a maximum depth of 16 feet below the ground surface, using 4-inch-ID hollow stem augers. Above the water table, soil samples were continuously retrieved with a 2-foot-long, 3-inch-OD California-modified split-spoon sampler lined with four, 6-inch-long stainless steel sleeves in accordance with ASTM D 1586-84. Upon removal from the split-spoon sampler, the contents of the liners were screened for organic vapors using a PID and one of the 6-inch stainless steel liners was selected for potential laboratory volatile organic analysis. The stainless steel liners from each spoon were then capped, wrapped in aluminum foil, and labeled. Samples from below the water table were collected with a 2-foot-long, 2-inch-OD split-spoon sampler.

At the completion of each soil boring, the borehole was backfilled with grout, and samples were selected for analytical and geotechnical analysis as described in section 2.2.2.3. Samples were selected for further analysis based on the highest PID readings encountered during screening.

The borings were conducted under the supervision of, and logged by, an M&E geologist. Decontamination of drilling and sampling equipment was performed before and after each borehole was drilled and is described in section 2.1.9. Geologic logs completed for each soil boring are presented in Appendix D. Lithologic data from selected soil borings were incorporated into geologic cross-sections, which are presented in section 3.2.2. Physical data recorded at each boring location are summarized in Table 2-6.

Soil boring locations in each of the four areas of concern were sited based on surface geophysical surveys (section 2.1.2). However, boreholes were not advanced in areas where in-phase anomalies were indicated by the EM or GPR data, since the presence of metallic debris would possibly have resulted in refusal prior to the soil boring target depth of 15 feet. The rationale for boring placement in each area is summarized below. The results are also briefly described because they were used to help develop the groundwater monitoring program described in the Final Work Plan Amendment (M&E, 1994e). The soil boring results are discussed further in section 3.2.2.3.

B&M Railroad Landfill. Fourteen soil borings (BH-01 to BH-14) were drilled to investigate elevated apparent terrain conductivities in two areas of the landfill delineated by EM data. On both the north and south sides of the study area, a strong in-phase component was present, suggestive of buried metallic debris. Apparent terrain conductivities were also more elevated in the northern and southern portions of the study area. Soil boring locations were selected in areas with elevated apparent terrain conductivities and away from, or on the edge of, areas where strong in-phase anomalies were indicated. This rationale was used so that soil borings could be advanced where soil or groundwater contamination may be present, without potential obstructions that would be caused by metallic debris.

During the advancement of the soil borings, fill materials such as wood (logs and railroad ties), twigs, leaves, glass, concrete and metal, mixed with silt and sand, were encountered. Thickness of the fill ranged from 2 to 16 feet. Below the fill, between 4 and 9 feet of natural materials, including peat and silty sands, were encountered.

RSI Landfill. Twelve soil borings (BH-15 to BH-26) were sited to investigate elevated terrain conductivities in the RSI Landfill and to verify the fill boundary as delineated by the EM data. Eight soil borings were located in the center of the study area where elevated apparent conductivities were present but along the edge of or away from locations where strong in-phase anomalies were indicated. This rationale was used so that borings could be advanced where soil or groundwater contamination potentially exists without obstructions that may be caused by metallic debris. Four additional soil borings were located on the perimeter of the landfill to verify the absence of fill materials which was suggested by the EM data.

During the advancement of soil borings BH-15 to BH-20, natural materials (stratified drift) were encountered. At BH-21 to 26, fill materials such as paper, cardboard, plastic, metal, glass, wood, ash, brick, cloth, and twigs were encountered.

B&M Locomotive Shop Disposal Areas. Two soil borings in Area A (BH-27 and BH-28) and six soil borings in Area B (BH-29 to BH-34) were advanced to investigate areas where anomalies were suggested by geophysical survey data. In Area A, elevated apparent terrain conductivities were present with corresponding in-phase anomalies, suggesting metallic debris in the suspected fill material. In Area B elevated apparent terrain conductivities were present with corresponding in-phase anomalies, suggesting metallic debris. However, in several locations a corresponding in-phase anomaly was not present. At these locations a GPR survey was conducted to investigate the presence or absence of metallic objects, and test pits were excavated as discussed in section 2.1.3. In both areas A and B, the soil boring locations were selected to verify fill boundaries as delineated by EM data, while keeping away from places where strong in-phase and GPR anomalies were indicated. This rationale was used so that soil borings could be advanced where soil or groundwater contamination potentially exists, without obstructions caused by metallic debris.

In Area A, BH-27 encountered sandy material, and BH-28 encountered fill materials such as ash, coal, and wood. In Area B, borings encountered fill materials such as ash, coal, nails, plastic, glass, brick, wood (railroad ties), and slag.

Old B&M Oil/Sludge Recycling Area. Twelve soil borings (BH-35 to BH-46) were sited to verify anomalies of elevated apparent terrain conductivity values (greater than 30 mmho/m) that suggested three separate areas of buried oil and sludge. Four borings on the northern side of the study area (BH-35, BH-37, BH-41, BH-42) and one boring on the southern side (BH-40) were advanced to verify the extent of suspected oil/sludge as delineated by EM data. Six additional soil borings (BH-36, BH-38 and BH-43 to BH-46) were advanced in the center portion of the study area either to investigate small EM anomalies or to verify that the soils in these locations were not contaminated.

BH-35 to BH-42 encountered sandy fill materials including ash, slag, brick, glass, foam, and other miscellaneous trash. Oily materials were encountered at BH-38, BH-39, and BH-40. Fill thickness ranged from a minimum of 0 to 6 feet at BH-35, BH-37, BH-38, BH-39, BH-42, BH-44, and BH-46, to a maximum of 6 to 15 feet at BH-38, BH-40, and BH-41. Natural materials below the fill include sand, gravel, and peat. No fill was encountered at BH-36, BH-43 and BH-45.

2.1.5 Piezometer Installation

Eighteen piezometers were installed in groupings of three at each of the following areas: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, and the Asbestos Lagoons. The piezometers were installed to determine local shallow groundwater flow directions in each of these areas (Table 2-7). The locations of the piezometers are shown in Figure 2-5 and Figures 2-7 through 2-11. The piezometers were installed from November 29 to December 7, 1994.

The 18 piezometers were drilled using 4¼-inch-ID hollow stem augers. Soil samples were collected at selected intervals during the drilling to estimate the depth of the water table and thereby determine the screened interval. Split-spoon soil samples were collected using a 2-inch-OD split-spoon sampler in accordance with ASTM D 1586-84. Soil samples were collected for geologic logging and field screening.

Each piezometer was constructed using a 5-foot-long, 2-inch-diameter schedule 40 PVC well screen with a slot size of 0.010 inches and 2-inch-diameter schedule 40 PVC riser pipe. The piezometer screens were typically set just below the water table. The piezometers were backfilled with soil cuttings, if the cuttings were deemed to be non-hazardous (headspace less than 10 ppm), to a maximum of 2 feet below the ground surface. Boreholes that contained contaminated soils (headspace greater than 10 ppm) or that did not have enough soil cuttings for backfilling were backfilled or completed with clean filter sand (Morie #1 well gravel). A minimum 6-inch bentonite chip seal was installed above the sand pack. Clean potable water was added to the bentonite chips, which were then allowed to hydrate for a minimum of 1 hour.

Each piezometer was completed above ground using a 5-foot-long, 4-inch-ID, steel protective casing with an overlapping steel cap. The protective casing was secured by pouring concrete from the base of the casing to the surface and forming a concrete pad at the surface. The piezometers were secured by keyed-alike locks. The cap of each protective casing was permanently identified with the piezometer number using impact lettering. Following installation, the piezometers were developed as described in section 2.1.7.

Decontamination of drilling equipment was performed before and after the construction of each piezometer, as described in section 2.1.9. The piezometers were drilled and constructed under the supervision of, and logged by, an M&E geologist. Soil cuttings were also logged. Boring logs are presented in Appendix D. Piezometer installation diagrams are presented in Appendix E. Physical data collected during piezometer installation are presented in Table 2-8.

2.1.6 Monitoring Well Installation

Thirteen monitoring well clusters were installed in the vicinity of the following five areas of concern: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, and the Asbestos Lagoons. In addition, one background monitoring well cluster was installed upgradient of the Site, and two bedrock wells were added to existing OW clusters. In total, 43 new monitoring wells were installed from January 3 to March 1, 1995, as shown in Figure 2-5 and Figures 2-7 through 2-11. The monitoring wells were located in the vicinity of each of these areas of concern to further characterize groundwater quality relative to each area (Table 2-7). The final well locations were selected following assessment of the water level elevation measurements conducted in December 1994.

With one exception, each of the monitoring well clusters consisted of a shallow and a deep overburden well and a bedrock well. At MW-210 in the RSI Landfill, bedrock was encountered at 12½ feet below the ground surface; therefore, only a single overburden well and a bedrock well were installed at this location. Single bedrock monitoring wells were installed at existing overburden monitoring well clusters OW-20/OW-21 (Asbestos Lagoons) and OW-25/OW-26/OW-27 (upgradient of the RSI Landfill).

Split-spoon soil samples were collected during the monitoring well installations. Two types of split spoons were used during sample collection. A 2-inch-OD split-spoon soil sampler was used during the drilling of the deep overburden wells to collect overburden materials for geologic logging and field screening. Soil samples were collected continuously with the 2-inch sampler until the water table was encountered and at 5-foot intervals thereafter until bedrock was reached.

A 2-foot-long, 3-inch-OD, California-modified split-spoon sampler lined with four 6-inch-long stainless steel liners was used to collect soil samples intended for geotechnical analysis. The geotechnical sample intervals, which were typically collected during the drilling of the bedrock wells, were selected using the lithologic information determined during drilling of the deep overburden wells. Geotechnical samples were collected from each stratigraphic unit encountered during drilling. Twenty samples were selected and submitted for the analysis of total combustible organics, moisture content, grain size, porosity, and permeability. Results from the geotechnical analyses are presented in Appendix D.

Split-spoon samples were screened with a PID using a headspace method to screen for organic vapors during the drilling and sampling of the overburden wells. The headspace method consisted of placing a composited soil sample from each split spoon into a clean glass jar, which was then covered with aluminum foil and the lid secured. After approximately 5 minutes, the lid was removed and the aluminum foil was perforated with the tip of the PID and the organic vapor reading was recorded. If contamination was noted by either visual observation or field screening (PID readings greater than 10 ppm), drilling operations were halted and the EPA was notified. Two bedrock monitoring well locations (MW-207 and MW-213) yielded elevated PID readings in the borehole cuttings, denoting contamination. The EPA was notified, and a decision was made to install MW-207 and MW-213 using telescoped casing methods, discussed in section 2.1.6.3, to prevent transport of potential contamination to deeper levels.

Decontamination of the drilling and sampling equipment was performed before and after the construction of each monitoring well as described in section 2.1.9. The monitoring wells were drilled and constructed as described below under the supervision of, and logged by, an M&E geologist. Soil cuttings were also logged. Boring logs are presented in Appendix D. Well installation diagrams are presented in Appendix E. Physical data collected during monitoring well installation are presented in Table 2-8.

2.1.6.1 Overburden Monitoring Wells. The overburden monitoring wells were drilled using 4¼-inch-ID hollow stem augers or by spinning or driving 4-inch-ID, HW-type casing. All of the newly installed monitoring wells are constructed of 2-inch-ID PVC screen and riser. Overburden monitoring wells were installed with 10-foot screens with a slot size of 0.010 inches. The shallow overburden monitoring wells were installed with the top of the screen set a maximum of 5 feet below the water table. The deep overburden wells were installed with the bottom of the screen set at: 1) the top of the till, if present, 2) the base of the overburden, if the till was not present, or 3) within the till, if the outwash deposits were too thin to accommodate two screened intervals.

Each monitoring well was completed by installing an appropriately sized sand pack (Morie #0 well gravel) around the well screen. The sand pack extended from the bottom of the well screen to approximately 2 feet above the well screen. A 2-foot bentonite chip (or Volclay slurry) seal was placed on top of the sand pack and allowed to hydrate for approximately one hour. The remaining annular space was tremie grouted with a cement/bentonite grout. The grout consisted of Portland Type I/II cement mixed with clean potable water and 3 to 5% powdered bentonite.

The wells were completed with a 5-foot-long, 4-inch-ID, steel protective casing with an overlapping steel cap. The protective casing was secured by pouring concrete from the base of the casing to the surface and forming a concrete pad at the surface. The monitoring wells were secured using keyed-alike locks. The cap of each protective casing was permanently identified with the monitoring well number using impact lettering. Following installation, the monitoring wells were developed as described in section 2.1.7.

2.1.6.2 Bedrock Monitoring Wells. Bedrock monitoring wells were drilled by spinning or driving 4-inch-ID casing through the overburden and seating it into the top of competent bedrock. A 3⅞-inch roller bit was then used to advance the hole a maximum of 30 feet into competent bedrock using rotary drilling methods. The drill wash was screened and the cuttings were logged by an M&E geologist. Drilling times (feet/minute) and losses in drilling fluid circulation were noted during rock drilling as indicators of bedrock lithology and degree of fracturing.

The wells were screened across intervals that were considered most likely to contain water bearing fractures, as determined by the M&E geologist. Bedrock well screens and risers were constructed using 2-inch-ID schedule 40 PVC pipe. Bedrock well screens have a slot size of 0.020 inches and are 20 feet long. After the well screens were placed in the holes at the appropriate depths, sand packs were placed around the screens to a minimum of 2 feet above the top of the screen. Approximately 4 feet of bentonite chips (or Volclay slurry) were then placed above the sand packs. After allowing the bentonite chips to hydrate, the boreholes were tremie-grouted to the surface using a neat cement/bentonite grout.

The wells were completed in the same manner as the overburden monitoring wells (section 2.1.6.1). Following installation, the wells were developed as described in section 2.1.7.

Soil cuttings at two of the bedrock monitoring well locations (MW-207 and MW-213) yielded elevated PID readings. At MW-207B, PID screening of drilling water and drill cuttings from a borehole depth of 13 feet yielded maximum readings of 500 ppm. At MW-213B, elevated PID readings (20 to 25 ppm) on samples collected at the base of the overburden suggested the potential for introducing contamination into the bedrock. The wells were subsequently installed using telescoping methods, which are discussed below. Soil cuttings and drilling water deemed hazardous (headspace greater than 10 ppm) during the drilling of these two wells were disposed of as discussed in section 2.1.9.

2.1.6.3 Telescoped Well Installations. Bedrock monitoring wells MW-207B and MW-213B were installed using telescoped casing. Telescoped cased monitoring wells were drilled by driving 6-inch-ID, NW-type casing through the overburden and 1 to 2 feet into the semi-confining till layer or the top of the bedrock surface. After cleaning out the 6-inch ID casing with a 5⅞-inch roller bit, 4-inch ID steel casing was lowered into the borehole and spun approximately 2 feet into rock. The annulus between the 6-inch and 4-inch casing was then sealed by pressure grouting a cement/bentonite slurry under pressure down through the 4-inch casing until grout began to circulate out of the top of the 6-inch casing. The 6-inch casing was then removed from the borehole. Grout was added to the borehole as the 6-inch casing was removed to prevent the hole from collapsing. The grout was allowed to set for a minimum of 24-hours before drilling was resumed. The bedrock wells were then drilled and installed using the same bedrock monitoring well installation procedures described above in section 2.1.6.2.

2.1.7 Piezometer and Monitoring Well Development. All newly installed piezometers and monitoring wells were developed after allowing the grout seal to set for a minimum of 48 hours. In addition, between February 8 and March 2, 1995, nine existing monitoring wells were redeveloped, because evidence of siltation was present in these wells during the existing well inventory. These include: OW-01, OW-05, OW-10, OW-20, OW-25, OW-40, OW-44, OW-45, and OW-49.

Development was conducted to clear the sand pack of suspended fines and to improve the connection between the aquifer and the well screen. Monitoring wells were developed using either a centrifugal pump, a Waterra hand pump, a motor-driven Waterra pump, a bailer, or a combination of this equipment. Development procedures consisted of pumping and surging the well until clear water was produced or until field measurements stabilized.

Field measurements were made at regular intervals during well development using a HORIBA model U-10 water quality monitor and a PID. Field measurements recorded included temperature, pH, specific conductance, turbidity, and organic vapors. Development was conducted until the field readings stabilized to within 10% of the previous three readings, or until the maximum development time limit was reached. Piezometers and monitoring wells were developed for up to 2 and 3 hours, respectively.

Development water was placed in a container until it was screened with a PID for organic vapors. If the development water was deemed hazardous (headspace greater than 10 ppm), the development water was disposed of as discussed in section 2.1.9. Non-hazardous development water (headspace less than 10 ppm) was allowed to infiltrate into the ground at the well location.

Decontamination of development equipment was performed before and after the development of each piezometer, as discussed in section 2.1.9. The piezometers and monitoring wells were developed under the supervision of an M&E geologist. Development logs are presented in Appendix E.

2.1.8 Aquifer Testing

Slug tests are a commonly used technique for estimating hydraulic conductivity in aquifers because they can be conducted rapidly in the field with little setup required, and the resulting data can generally be analyzed quickly. This test involves rapidly displacing a volume of water within a well such that the water level in the well is changed from the water level in the surrounding aquifer. The rate of water level recovery in the well is then recorded. The resulting data are analyzed to estimate the hydraulic conductivity of the aquifer in the immediate vicinity of the well.

From August 7 to 11, 1995, slug tests were conducted in the 43 newly installed monitoring wells. A falling head (slug-in) test and rising head (slug-out) test were conducted for each well. If the static water level of a well was determined to intersect the screened interval ("drained" well geometry), two rising head tests were performed for that well and the falling head test was omitted.

Equipment used for slug testing included a water level indicator, a 10-psi pressure transducer, a Hermit 1000B or 1000C data logger, and a slug. A decontaminated pressure transducer was lowered into the well and secured at a depth of approximately 10 to 15 feet below the water table. The data logger was then programmed. A decontaminated slug was instantaneously introduced into (slug-in) or removed from (slug-out) the well, and the response was recorded by the data logger. The slugs used were sized to displace approximately 1½ feet of water within the annulus of the well.

The data were analyzed using the technique of Bouwer and Rice (1976 and 1989) with analysis software developed at M&E and tested against the original data published with the technique. Computer-generated worksheets and graphs for the slug tests are provided in Appendix E. Aquifer testing data are discussed in section 3.3.2.2.

2.1.9 Equipment Decontamination and Waste Disposal

During excavation, drilling, and piezometer and monitoring well installation activities, temporary decontamination pads were constructed in four of the areas where the field activities were being conducted. Decontamination pads were set up between the B&M Railroad Landfill and RSI Landfill Areas, in the B&M Locomotive Shop Disposal Area A, in the Old B&M Oil/Sludge Recycling Area, and adjacent to the Asbestos Lagoons. The decontamination pads consisted of a plastic-lined bermed area, which was large enough to accommodate a drilling rig and drilling equipment or backhoe, that sloped towards a shallow pit at one end. At the end of the field activities, the decontamination pads were decommissioned.

The backhoe bucket was decontaminated by steam cleaning before each excavation. The drilling rig and associated downhole equipment were steam cleaned before each borehole was drilled. Decontamination fluids drained into the lined pit, where they collected at one end of the decontamination pad. At the end of each work day, the decontamination water was screened using a PID. If the decontamination water was deemed nonhazardous (headspace less than 10 ppm), the water was pumped out of the pit and allowed to infiltrate into the ground at the location of the decontamination pad. If the water was deemed hazardous (headspace greater than 10 ppm), the water was drummed, labeled, and transported to the drum storage area (Figure 2-1).

Sampling and other field equipment were decontaminated by washing with Liquinox and tap water, followed by a tap water rinse, a methanol rinse only for stainless steel sampling equipment, and a final rinse with deionized water. Sampling equipment was then wrapped in aluminum foil and labeled, if stored prior to use. The types of equipment decontaminated in this manner included well development equipment, water level indicators, and stainless steel liners, trowels, and bowls. For groundwater sampling, pre-cleaned dedicated Teflon tubing that did not require decontamination was placed in each well.

Wastes generated during field work that were deemed hazardous were drummed. Solids (soil cuttings, soil samples, or benthic samples) and liquids (development or drilling water or decontamination fluids) were typically disposed of in separate drums. The drums were labelled and transported to the drum storage area until disposal. The drum storage area was kept secured at all times.

All drums containing waste (solid or liquid) were processed for disposal through a waste disposal subcontractor, ENPRO Engineering Services of Newburyport, Massachusetts. All drums were removed from the Site on December 19, 1995, and transported to an EPA-approved hazardous waste disposal facility.

2.2 ENVIRONMENTAL SAMPLING

Environmental samples were collected from June to October 1993 for the following media:

- Surface soil
- Subsurface soil
    - Test pit soil
    - borehole soil

- Surface water
- Sediments
- Shallow overburden groundwater

In addition, groundwater samples were collected during two sampling rounds: March-April and July 1995.

A detailed description of the field sampling procedures and activities and laboratory analyses, methods, and protocols are provided, respectively, in the Final Field Sampling Plan (M&E, 1993b), the Final Quality Assurance Project Plan (M&E, 1993c), and the Sampling and Analysis Plan Addendum (M&E, 1994f).

2.2.1 Chemical and Geotechnical Analyses

Environmental samples collected by M&E during the RI field investigation were submitted to laboratories for chemical analysis under the EPA Contract Laboratory Program (CLP) and EPA's delivery of analytical services (DAS) work assignment. Laboratory analyses performed through the CLP system consisted of routine analytical services (RAS) and special analytical services (SAS). The RAS analyses included:

- Target compound list (TCL) volatile organic compounds (VOCs)
- TCL semivolatile organic compounds (SVOCs)
- TCL pesticides/PCBs
- Target analyte list (TAL) metals (total only)
- Cyanide

The SAS/DAS analyses included:

- Low-level pesticides/PCBs
- Total petroleum hydrocarbons (TPH)

- Water quality parameters (WQPs)
  - Alkalinity
  - Biological oxygen demand (BOD)
  - Chloride (Cl)
  - Chemical oxygen demand (COD)
  - Nitrate/nitrite as nitrogen (NO_3/NO_2)
  - Total phosphorous (Total P)
  - Sulfate (SO_4)
  - Total dissolved solids (TDS)
  - Total suspended solids (TSS)
  - Total organic carbon (TOC)

In addition, soil boring and sediment samples were submitted to a subcontracted laboratory, Geotesting Express of Concord, Massachusetts, for the geotechnical analysis of:

- Grain size
- Porosity
- Permeability
- Total combustible organics (TCO)
- Moisture content

Specific gravity was also reported, as it was calculated as part of the analysis for porosity. The number of samples collected and analyses performed are summarized in Table 2-9. The analyses performed using the CLP are further described in the Final Quality Assurance Plan and the Sampling and Analysis Plan Addendum (M&E, 1993c and 1994e). A SAS/DAS method for low-level pesticide/PCBs in surface water was developed from the CLP pesticide/PCB method to meet the risk-based criteria (detection limit of 0.14 μg/L). The TPH method was modified from U.S. EPA (1986e). Other SAS/DAS analyses (e.g., TOC, alkalinity) are typical water quality parameters. The SAS specifications are presented in the Final Quality Assurance Project Plan (M&E, 1993c). The DAS analytical specifications (M&E, 1994d) were approved by EPA.

2.2.2 Soil Sampling and Analysis

Soil samples were collected from surface soils, test pits, and soil borings during the RI field investigation. Surface soils were collected between July 22 and September 5, 1993, and were submitted for chemical and geotechnical analyses. Test pit excavations were performed between August 16 and August 24, 1993, using a backhoe with a maximum bucket reach of 12 feet. Test pit soil samples were submitted only for chemical analyses. Soil borings were advanced to a maximum depth of 16 feet below ground surface and were submitted for both chemical and geotechnical analyses.

2.2.2.1 Surface Soil Sampling. A total of 79 surface soil samples were collected using three methods. The 68 surface soil samples collected from the B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, and the Contaminated Soil Area were composited as described below. In addition, discrete samples were collected from three background locations and two historical locations. A drill rig was then used to collect an additional six discrete samples from the Old B&M Oil/Sludge Recycling Area. The locations of the surface soil samples are shown in Figure 2-12, and Table 2-10 summarizes the surface soil sampling locations by area. Surface soil samples were submitted for the analysis of VOCs, SVOCs, pesticides/PCBs, metals, cyanide, TPH, TCO, and moisture content. Table 2-9 lists the sample quantities submitted for each analysis. The results of the surface soil sampling are discussed in section 4.2.1.

Composited Samples. Samples were collected at a depth of 0 to 12 inches from ground surface using a hand auger or stainless steel spade. Immediately upon removing the auger, the extracted soil and the hole were screened for organic vapors using a PID. Generally, samples from five locations per acre were composited (except VOCs) such that one composite sample per acre was submitted for laboratory analysis. However, some areas of the Site were hardpacked or covered with asphalt, making recovery of five individual samples impossible. In these cases, the accessible areas within the acre were sampled and composited. Any deviations from the Final Field Sampling Plan (M&E, 1993b) were noted in the logbooks.

From each of the five locations, a hand-augered sample of soil from the top 12 inches was transferred to a stainless steel bowl. The soil was homogenized in the bowl using a hand trowel and then transferred to the appropriate sample containers. Specific surface soil sampling procedures are provided in the Final Field Sampling Plan (M&E, 1993b).

Samples for volatile organic analysis were, however, not composited. Rather, a 40-ml vial was filled at each of the five locations. At the same time, a small aliquot of soil from each location was placed in its own plastic bag and sealed. Once sampling was completed at all five of the locations to be composited, each plastic bag of soil was vigorously shaken and screened for organic vapors by inserting the tip of a PID into the bag. Sample screening allowed the field team to be selective in deciding which samples would be sent for analysis. The sample submitted for volatile analysis corresponded to the bag of soil with the highest PID reading. If PID readings were not detected in any of the five bagged soils, the sample submitted for analysis was selected based on staining, noticeable odors, visual appearance, or technical judgement.

Discrete (Non-Composited) Samples. The two locations known to have high historic lead concentrations and the three background sample locations were sampled in a discrete manner. At each of these locations, a hand auger or stainless steel spade was used to remove the top 12 inches of soil. The excavated soil was collected and processed in the same manner as described above for composited samples, except that more than one hole was dug at each location if greater sample volume was needed.

Drilling Rig Samples. Six surface soil samples were collected from the Old B&M Oil Sludge Recycling Area. Because a large portion of the area was covered with asphalt, surface soil samples were retrieved using a drill rig and a split-spoon sampler. These samples were not composited, but were collected from 0 to 1 foot at six discrete locations. An interval of 0 to 2 feet was used when soil recovery was poor, and the sampler was redriven adjacent to the location of the first attempt.

2.2.2.2 Test Pit Soil Sampling. Samples were collected from 24 of 27 test pits which were excavated in the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas, and the Old B&M Oil/Sludge Recycling Area between August 16 and August 24, 1993. Test pit locations are shown in Figures 2-7 through 2-9. The sampling locations and depths are summarized by area in Table 2-11. Section 2.1.3 describes the rationale for selection of the test pit locations and details the excavation methods used.

During excavation activities, a representative sample for analysis was collected directly from the backhoe bucket at each test pit. Samples were selected based on the detection of organic vapors by field screening with a PID. If no readings were detected, visual appearance (e.g., soil staining, fill materials) and professional judgement were used for sample selection.

Prior to collecting the sample for volatile organic analysis, disturbance of the soil was minimized. After a 40-ml vial was filled, additional soil was collected into a stainless steel bowl, homogenized using a hand trowel, and transferred to the remaining sample containers. Specific test pit sampling procedures are described in the Final Field Sampling Plan (M&E, 1993b). Samples were submitted for the analysis of VOCs, SVOC, pesticides/PCBs, metals, cyanide, and TPH. The sample quantities submitted for analysis are summarized in Table 2-12. The results of the test pit soil sampling are discussed in section 4.2.1.

2.2.2.3 Soil Boring Sampling. A total of 46 soil borings were advanced in the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas, and the Old B&M Oil/Sludge Recycling Area between August 24 and September 3, 1993. The locations of soil borings are shown in Figures 2-7 through 2-10; sampling locations and depths are summarized by area in Table 2-12. Section 2.1.4 describes the rationale for selection of the boring locations and details the drilling methods used. The sampling methods and protocols that were used to collect soil boring samples during drilling are summarized in the following text.

During drilling activities soil samples were continuously retrieved with a 2-foot-by-3-inch-OD, California-modified split-spoon sampler lined with four 6-inch-long stainless steel liners. Upon removal from the split-spoon sampler, the contents of the liners were field screened for organic vapors using a PID. The contents were also visually inspected for staining and other apparent signs of disturbance or contamination.

Immediately after screening, one of the 6-inch stainless steel liners was selected for potential laboratory volatile organic analysis. To minimize potential volatilization during storage, this liner was immediately covered on both ends with 2-inch Teflon tape and plastic end caps, secured with rubber bands, labeled, and placed on ice. A small aliquot of soil was then taken from the two split-spoon liners adjacent to the liner removed for potential volatile organic analysis. This aliquot was placed into a plastic bag and labeled with the appropriate depth interval. The remaining stainless steel liners from each split spoon were wrapped together in aluminum foil and labeled.
Upon completion of the borehole, two samples were selected for further chemical analysis. The samples were selected by screening each plastic bag of soil that was set aside earlier for organic vapors by shaking the bag vigorously and screening with a PID. The samples were generally selected for analysis based on the highest PID readings. If PID readings were not detected, odor, visual appearance, and professional judgement were used for sample selection.

Due to subsurface obstructions, soil recovery was often insufficient for sample collection. If insufficient sample was recovered from one 2-foot split-spoon interval, consecutive intervals were composited to obtain sufficient sample for all analyses, with the exception of volatile organics. Samples for volatile organic analysis were always collected as discretely as possible, as described above. If sample recovery was insufficient, due to the presence of cobbles, boulders, or other obstructions, and after compositing several spoon intervals, the following priority was used for submission of analytical samples: VOCs, SVOCs, pesticides/PCBs, metals, cyanide, TPH, TCO, and grain size.

At the completion of drilling activities at each soil boring location, up to two sample-depth intervals were selected for chemical and geotechnical analysis. For samples receiving chemical analysis, the contents of the split-spoon liners from the depths selected for analysis were homogenized using a stainless steel bowl and trowel. The homogenized soil was then transferred to the appropriate sample containers. For samples receiving geotechnical analysis, the split-spoon liners were submitted intact to the laboratory. Specific soil boring sampling procedures are described in the Final Field Sampling Plan (M&E, 1993b).

The samples selected from each soil boring were submitted for the analysis of VOCs, SVOCs, pesticides/PCBs, metals, cyanide, TPH, TCO, moisture content, grain size, porosity, and permeability. The sample quantities submitted for analysis are summarized in Table 2-9. The results of the soil boring sampling are discussed in section 4.2.1.

2.2.3 Site-Wide Surface Water Sampling and Analysis

Forty-six locations across the Site and study area were chosen for surface water sampling. Surface water sampling locations were selected as discussed in section 2.1.1.6. Surface water samples were collected from June 9 through 22, 1993, and September 14 through 22, 1993. The June round coincided with a period of higher flow, and the September round coincided with a period of lower flow at the Site. Surface water sampling locations are shown in Figure 2-6. Table 2-13 summarizes the surface water locations that were sampled according to area and collection round.

All 46 surface water locations were sampled during June 1993. During the September 1993 sampling event, surface water locations SW-22, SW-108, SW-109, and SW-311 were not sampled due to dry conditions. In addition, the staked location at SW-319 could not be found in September 1993 because of overgrowth or removal of the stake; therefore, a new location was staked, labeled as SW-319A, and sampled.

Prior to sample collection, field parameters including temperature, pH, specific conductance, and dissolved oxygen (DO) were recorded. Surface water samples were then collected by immersing a sample container in the standing water, approximately 6 inches below the water surface, and allowing it to slowly fill. Containers used for volatile organic analysis were filled first to reduce the loss of volatiles caused by disturbance of the standing water. Each container was then preserved and checked to insure that no air bubbles were present. The remaining containers were then filled and preserved accordingly. Specific sampling procedures are described in the Final Field Sampling Plan (M&E, 1993b).

All surface water samples were submitted for the analysis of VOCs, SVOCs, pesticides/PCBs, total metals, cyanide, TOC, and alkalinity. The sample quantities submitted for analysis are summarized in Table 2-9. The results of the surface water sampling are discussed in section 4.2.3.

2.2.4 Site-Wide Sediment Sampling and Analysis

Forty-six sediment samples were collected at the same locations and times as surface water samples (Figure 2-6) during June and September 1993. Table 2-13 summarizes the sediment locations that were sampled by area and collection period. Four of the 46 sediment locations that were sampled in June 1993 were not sampled in September 1993 because of dry conditions (SD-108, SD-109, SD-311 and SD-319). At SD-319 a new location was staked, labeled as SD-319A, and sampled.

Five additional sediment locations were only sampled in June 1993: SD-318, and SD-323 through SD-326. Sample SD-318 was collected adjacent to the former salt/sand pile in the vicinity of the B&M Locomotive Shop Disposal Areas. In addition, two sediment samples were collected from each of the two uncovered asbestos lagoons (SD-323 through SD-326).

A hand auger was used to collect sediment samples. The auger was advanced to a depth of approximately 6 inches below the sediment surface. Upon removal, sediment was transferred from the auger to a stainless steel bowl. Disturbance of the sediment prior to collection of samples for volatile organic analysis was minimized. Detritus, leaf litter or other organic materials were carefully removed, and as much water as possible was decanted from the sediment. Containers used for volatile organic analysis were filled first. The remaining contents of the bowl were homogenized using a hand trowel and transferred to the remaining sample containers. Specific sediment sampling procedures are described in M&E's Final Field Sampling Plan (M&E, 1993b).

All sediment samples were submitted for the analysis of VOCs, SVOCs, pesticides/PCBs, metals, cyanide, TPH, TCO, moisture content and grain size. Approximately six randomly selected samples from the high-flow round were also submitted for TOC analysis. TOC analysis was done on all samples collected during the low-flow round. The sample quantities submitted for analysis are summarized in Table 2-9. The results of the sediment sampling are discussed in section 4.2.4.

2.2.5 Groundwater Sampling and Analysis

Groundwater was sampled and analyzed at two different periods during the RI field investigation. In September and October, 1993, groundwater samples were collected from shallow overburden using a Geoprobe, then field-screened and analyzed for a limited list of volatile organic compounds using a field gas chromatograph (GC). The results of the field analysis were used to aid in the selection of monitoring well locations, as described in section 2.1.6.

Two rounds of groundwater samples were collected from monitoring wells in March-April and July, 1995. The groundwater samples were submitted for laboratory analysis of chemical parameters.

2.2.5.1 Groundwater Screening and Analysis by Gas Chromatography. Shallow overburden groundwater samples were collected from 50 locations from the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas, the Old B&M Oil/Sludge Recycling Area, and the Asbestos Lagoons from September 27 through October 8, 1993. The groundwater screening locations were situated downgradient of the suspected source areas, as determined by the first two rounds of water level measurements (section 2.1.1.4). The groundwater locations sampled and field analyzed for limited screening and analysis purposes are shown in Figures 2-7 through 2-11. The sampling locations are summarized by area in Table 2-10.

A truck-mounted Geoprobe sampling system was used to retrieve the samples from a maximum depth of approximately 12 feet. The samples were screened using the field GC to analyze for chlorinated and aromatic VOCs. The sampler used to collect the groundwater samples was dependent upon the specific conditions encountered in the area. Most often, a mill-slotted sampler was used in conjunction with Teflon tubing that was attached to a peristaltic pump to draw groundwater to the surface.

In areas where vehicle access was limited, such as the B&M Railroad Landfill, the sampling technique was modified. A slam-bar was used to advance a pilot hole to a depth of 3 feet. Once the hole was advanced, Teflon tubing attached to a peristaltic pump was used to draw groundwater to the surface.

It was not necessary to purge the well points prior to sample collection, since the clarity of the sample improved after a short purge time. If sample volume allowed, an additional aliquot was collected for the measurement of pH, specific conductance, and temperature.

Groundwater samples were collected in 40-ml vials and checked to insure no air bubbles were present. Prior to analysis by field GC, approximately 10 ml of sample were removed from the vial using a clean syringe. The vials were then warmed in a water bath (approximately 70°C) for at least 20 minutes. Once warmed, approximately 50 to 100 μl of "gas" from the headspace of the vial were withdrawn through the vial septum using a gas tight syringe. The "gas" was then injected into the field GC, which was calibrated prior to sample collection.

Groundwater samples were screened using a field GC for the following VOCs: benzene, chlorobenzene, 1,1-dichloroethene, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, ethyl-benzene, tetrachloroethene, toluene, *m/p*-xylene, *o*-xylene, and vinyl chloride. The method used was a modification of EPA Region I Volatile Organic Screening for Aqueous Samples (1990c). The specific groundwater sampling and screening procedures are described in the Final Field Sampling Plan (M&E, 1993b). The sample quantities that were submitted for analysis are summarized in Table 2-9. The results of the groundwater screening are discussed in section 4.2.2.

2.2.5.2 Groundwater Sampling and Analysis of Monitoring Wells. Groundwater samples were collected from monitoring wells screened in shallow overburden, deep overburden, and bedrock during the RI field investigation. A total of 34 existing and 43 new monitoring wells were sampled during each of two rounds: March 28 to April 10, 1995, and July 17 to 28, 1995. New and existing monitoring wells from which groundwater samples were collected are shown in Figure 2-13 and are summarized by flow zone in Table 2-14.

Monitoring wells were sampled using an adapted procedure from the EPA Region I Groundwater Procedure for Low Flow Purge and Sampling (1994c) as modified in M&E's Sampling and Analysis Plan Addendum (1994f). Under ideal conditions the wells were purged and sampled at a flow rate not exceeding 500 ml/min, with no more than 0.3 feet of drawdown below original static water-level and a total of three well-screen volumes removed before sampling. However, because of differing field conditions such as poor recharge, excessive drawdown, or poor stabilization of field parameters, certain modifications to the low-flow procedures were made in the field (Figure 2-14). The specific sampling procedures used at each well are summarized in Table 2-15.

A peristaltic pump with dedicated Teflon tubing was used to purge and sample each of the wells. Prior to sampling, the purging rate was frequently monitored and, when necessary, regulated. The purge water was also monitored with a HORIBA meter at frequent intervals using a flow-through cell for field parameters including: specific conductance, temperature, turbidity, DO, oxidation/reduction potential (Eh), and pH. Attempts were made to attain stable groundwater conditions, but, in some cases as described above, well conditions did not permit this. Groundwater was considered stable when pH and specific conductance were within 10% for three consecutive measurements and turbidity was less than 5 NTU. Even if stable conditions could not be attained, the well was purged for no longer than four hours. Field parameters were measured again upon the completion of sample collection. Field parameter measurements are recorded on well sampling worksheets presented in Appendix F.

During sample collection, containers used for volatile organic analysis were filled first. Each container was then preserved and checked to insure that no air bubbles were present. The remaining containers were then filled and preserved accordingly. Specific sampling procedures are described in the Final Field Sampling Plan (M&E, 1993b). All groundwater samples collected during the two sampling rounds were submitted for the analysis of VOCs, SVOCs, pesticides/PCBs, metals, cyanide, and TPH. In addition, 20 groundwater samples from each sampling round were submitted for water quality parameters (WQPs) including: TOC, BOD, COD, NO_3/NO_2, alkalinity, Cl, total P, SO_4, TDS, and TSS.

2.3 ANALYTICAL DATA VALIDATION AND REVIEW

All field and analytical data obtained during the RI field investigation are presented in sections 3.0 through 7.0 of this report. The following sections discuss data validation and use as well as any additional data reviews.

2.3.1 Data Validation and Use

Quality control (QC) samples were taken and submitted for laboratory analysis to monitor precision, accuracy, and cross-contamination throughout the sampling episode. These samples included trip blanks, equipment blanks, bottle blanks, field duplicates, and matrix spike/matrix spike duplicate samples. Collection frequency for these QC samples is summarized in Table 2-9.

All chemical data generated from the RI field investigation were validated to determine their usability in subsequent evaluations of the RI. All RAS data and SAS/DAS pesticide/PCB data were validated to Tier III as specified by EPA (1993e), and in accordance with the following documents:

- *EPA Region I Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses* (U.S. EPA, 1988a); modified to meet criteria in the current Statements of Work (SOWs) for RAS Organic Analyses (U.S. EPA, 1993a)
- *EPA Region I Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (U.S. EPA, 1989f); modified to meet criteria in the current SOWs for RAS Inorganic Analyses (U.S. EPA, 1993b)

All other SAS/DAS data were reviewed and validated according to QC criteria set forth in the respective individual SAS requests and DAS analytical specifications.

Data found to be suspect during the validation process were qualified, and a description of the discrepancy was noted in the validation summary. Positive and non-detect results that were shown to have serious QC problems were rejected and flagged with an "R." Positive results that were shown to exhibit poor precision or accuracy were qualified as approximated and flagged with a "J." Nondetect results that were shown to exhibit poor precision were flagged with a "UJ." Nonqualified positive results were found to meet all validation criteria. Nondetect results that were found to meet the validation criteria were shown as the quantitative limit or detection limit followed by a "U" qualifier. Rejected values were considered as non-usable results for subsequent RI evaluations. Approximated and nonqualified results were used in further RI evaluations, but the qualified data were first reviewed to establish their usability.

2.3.2 Additional Data Review

Validated data for environmental samples are presented in Appendix F by media. The validated data were used in subsequent evaluations of the nature and extent of contamination and in baseline risk assessments. During these evaluations, data that were different from the rest of a data set were reviewed further to see if there were reasons (i.e., laboratory or field artifacts) that were not apparent during validation, but may affect the usability of the data. The results of the additional review are discussed below. Also discussed are data that appear to be anomalies (i.e., metals) because of qualification during validation.

Since the individual pieces of data that were further reviewed are too numerous and widely varied, only data that were found to result in a different interpretation than is suggested by validation are discussed below. These results are embellished in the discussion of the nature and extent of contamination (section 4.0) only where it is appropriate and important. Alterations were not made to validated data, tables, and figures based on the results discussed below.

Surface and Subsurface Soil, Surface Water, and Sediment Data. Acetone, 2-butanone (MEK), methylene chloride, and phthalates are common laboratory and field contaminants. During validation, values for these organic compounds were qualified when criteria were not met. During data evaluation, the data for these compounds were more closely reviewed to evaluate the usability of the detected values that were reported following data validation. The usability was drawn into question during data evaluation for the following reasons:

- No discernable pattern of spatial distribution was apparent
- All of these compounds are common laboratory contaminants (according to Region I data validation guidelines)

In addition, acetone was detected primarily in surface soil and sediment on certain sample collection dates. Acetone is also frequently detected in laboratory and field QC blanks, suggesting that the laboratory is the source. 2-Butanone (MEK) is often found in low-grade acetone commonly used by laboratories. In most samples where MEK was detected, higher concentrations of acetone were also reported, which were qualified as nondetected. Additionally, the presence of acetone and MEK in surface soil and sediment is curious, since both are readily mobile chemicals and would tend to partition rapidly. In this respect, the presence of MEK and acetone can be attributed to laboratory contamination.

Methylene chloride is also a commonly used laboratory solvent. Similar to acetone and MEK, methylene chloride was reported as detected only on certain sample collection dates. Often concentrations were within the range of methylene chloride results that had been qualified as nondetected during validation. In addition, methylene chloride was often found in samples that also had detectable quantities of acetone. In this respect, the occurrence of methylene chloride is likely related to the contamination from solvents commonly used in the laboratory.

Although bis(2-ethylhexyl)phthalate (BEHP) is also a common laboratory contaminant, the presence of other phthalates suggest that phthalates may be a true site contaminant. Phthalates, which are often used as plasticizers in paints, would likely be found on site in landfills or other locations where paint removal products were disposed of. In this regard, BEHP cannot be dismissed as an artifact of laboratory conditions.

During validation, it became evident that chloroform was generally detected in all field QC samples, including trip, equipment, and bottle blanks, at concentrations ranging from 9 to 64 $\mu g/l$. The chloroform detected in field QC samples does not seriously affect the volatile organic data, since chloroform was detected in few samples. When detected in samples, chloroform concentrations were generally estimated "J." The source of the chloroform in the field QC samples was believed to originate from the HPLC-grade water used for field QC samples.

In general, interpretation of metal data is sometimes difficult. Some of the data may not be usable because of limitations during analysis as well as subsequent qualifications of data during validation. For instance, matrix effects and elemental interferences typically increase sample detection limits and reduce quantitative accuracies, particularly at low concentrations. Difficulty in quantifying certain metals (i.e., antimony, magnesium, vanadium, and arsenic) is directly related to the concentration of that metal and the concentration of interfering elements (i.e., iron, aluminum). In general, quantitation becomes less accurate and precision is poorer as concentrations approach method detection limits.

Qualification of metal data during validation, for both aqueous and solid matrices, resulted in the non-usability of some data. One of the most common qualifications occurred because of the detection of metals in QC blanks. This resulted in metal data being qualified as nondetected (the sample detection limit was raised to the detected value) because validation criteria were not met. In solid matrices, this type of qualification is enhanced since the QC blanks, which are water, are not directly related to the solid matrices to which they are applied. This issue is most evident in surface soil and subsurface soil and sediment where calcium and sodium were reported as nondetected, although these particular metals are normally major soil components. Because this case was widespread, it is included in the discussion of analytical data in sections 4.2.1 and 4.2.4. However, other metal data that were reported as nondetected were not as consistent as the above case since it was generally limited to a particular sample or few samples for any given medium and sampling round. Consequently, these more individualized occurrences were not noted unless appropriate and important.

Similarly, a lot of groundwater data were qualified for aluminum and iron because of the detection of these metals in QC blanks. As a result, aluminum and iron were reported as nondetected for some of the groundwater samples. This is discussed in section 4.2.2 where appropriate.

2.4 SITE SURVEYING

Howe Surveying Associates, Inc., of North Chelmsford, Massachusetts, a licensed Massachusetts surveyor, surveyed locations and elevations for the following sampling and monitoring locations:

- Existing monitoring wells
- Test pits
- Soil borings
- Staff gauges
- Surface soil sampling locations
- Surface water/sediment sampling locations
- Groundwater field screening locations

Guerriere and Halnon Engineering and Land Surveying of Franklin, Massachusetts, a licensed Massachusetts surveyor, surveyed locations and elevations for the following sampling and monitoring locations:

- New piezometers
- New monitoring wells
- Seepage meters

Surveying had vertical and horizontal accuracies of 0.01 and 0.1 feet, respectively. Massachusetts State Plane Coordinates were established for each surveyed location. Figure 2-15 shows the Massachusetts State Plane Coordinate grid overlaid onto the site base map.

Elevations were referenced to NGVD datum. For monitoring wells, elevations were surveyed from notches made on the inside PVC riser pipe and on the outside of the steel casing of MW-213B and MW-207B, which have no PVC pipe. For piezometers, elevations were surveyed from notches made on the inside riser pipe. These notches served to establish elevation control points from which water levels were measured in the monitoring wells and piezometers. The top of a heavy-gauge steel fence post was used as a vertical and horizontal survey point for each staff gauge and seepage meter. The survey data are included in Appendix B.

2.5 SITE MAPPING

A base map of the Site was produced with ARC/INFO, a geographic information system (ARC/INFO). The topographic map of the Site includes buildings, roads, streams, rivers, existing and new monitoring wells, and other pertinent features. The map was created by overlaying surveyed buildings, roads as well as wetlands, ponds, canals and streams delineated by M&E onto available existing site maps to develop a comprehensive site base map. The base map was used to create figures used in this report.

SECTION 3.0
SITE CHARACTERISTICS

3.1 GEOGRAPHIC SETTING

The Site is located in North Billerica, Massachusetts, which is approximately 8 miles south of the New Hampshire border. The Site is approximately centered at a position described on the state coordinate system as North 577148, East 662935, or about 42°35'00" north latitude and 71°16'00" west longitude. The altitude of the Site is approximately 115 feet (35 meters) above mean sea level. This section presents information on the local climate, topography, soils, demographics, current land use, geology, and hydrogeology.

3.1.1 Climate

The climate at the Site is seasonably variable. The following summary of meteorological data is based on measurements taken at stations in Boston (Logan Airport), Bedford, and Lowell, Massachusetts. The data are maintained at the National Climatic Data Center in Asheville, North Carolina. Climatological data are included in Appendix E.

Based on data collected from 1961 to 1990, the average annual minimum and maximum daily temperatures at Lowell are 49°F and 60°F (Owen and Ezell, 1992). Meteorological data are also available from Boston and Bedford. However, due to its proximity to the Site, the monitoring station at Lowell is likely to be most representative of site conditions. The coldest month is January with mean minimum and maximum temperatures of 15°F and 34°F, respectively. The warmest month is July with mean minimum and maximum temperatures of 62°F and 85°F, respectively. Normally, temperature varies about 20°F between the daily low and high temperatures at Lowell, with a wider range in late summer and a narrower range in early winter. Average monthly temperatures tend to vary a few degrees from year to year. The average temperature over calendar year 1994 was about 1°F warmer than normal (based on Boston data; NOAA, 1995).

The Site receives approximately 42 inches of precipitation annually which is fairly evenly distributed throughout the year, based on Lowell data collected from 1961 to 1990 (Owen and Ezell, 1992). Precipitation occurs one day in three, on average, with a slightly higher frequency from March to May and a slightly lower frequency from July to October. At Boston, the average annual snowfall is 42 inches. Snow is typically recorded from November to April, but about half the snowfall occurs in January and February. Annual snowfall at the Site is likely to exceed the 42 inches recorded at Boston due to the colder winter temperatures at the Site. Based on Boston measurements from 1961 to 1990, the area receives approximately 58% of possible sunshine.

Prevailing winds at Boston are northwest or west-northwest from December to April and southwest from May to November (NOAA, 1995). The average wind speed at Boston is 12 miles per hour (mph), with higher average wind speeds in the winter and lower averages in the summer. Winds of 30 mph or more may be expected on at least one day in every month of the year at the Boston station. However, winds are likely to be lighter at an inland location such as the Site.

Over the course of a year, the relative humidity ranges from 58 to 72% on an average day in Boston, with the highest relative humidity levels occurring during the early morning and the lowest at midday (NOAA, 1995). From December to March the relative humidity is lower, since the prevailing winds in the vicinity of the Site are from the northwest, bringing cool, dry air. From April to November, the relative humidity is higher since the prevailing winds are from the southwest, bringing warm moist air.

3.1.2 Physical Geography

The Site is located in eastern Massachusetts, on the western side of the Seaboard Lowland section of the New England physiographic province, a subdivision of the Appalachian Highlands. The Seaboard Lowlands are characterized by extensive glacial outwash and till deposits overlying a complex of igneous and metamorphic rocks (Castle, 1959).

The physiography of eastern Massachusetts is controlled mostly by its recent geologic history. The advance and retreat of glaciers across New England and eastern Massachusetts during the last 20,000 years has effected the most significant, recent regional physiographic change in the region. Glacial sediments were superposed on the bedrock during the Pleistocene (Wisconsin) glaciation. The resultant physiography of this region of glacial deposits can be characterized as small hills with elevations of approximately 100 to 200 feet NGDV separated by small wetlands that are connected by meandering streams.

In addition to the surficial geology, the bedrock geology also has affected the physiography of the region. The Site lies within the Nashoba Terrane, a distinct and exotic lithologic block that is bounded by two northeast-trending faults. These faults are reflected in surficial features as evidenced by a long topographic lineament that traces the Bloody-Bluff fault, defined by discontinuous streams and valleys (Nelson, 1987).

Locally, the physiography of the Billerica area is characteristic of the region, which consists of small hills, wetlands and ponds, connected by small meandering streams. The Site lies on the western edge of the Shawsheen River drainage basin and is approximately 1.5 miles from the northward flowing Shawsheen River.

The Site has been altered by construction and development. Initial changes to the physiography of the Site most likely resulted from the construction of the Middlesex Canal. Changes to the Site topography may have also resulted from cut-and-fill techniques used to construct the industrial park buildings, parking areas, roads, railroad, and disposal areas. Further activities at the industrial park led to the filling of low-lying areas and wetlands during disposal activities.

The Iron Horse Industrial Park can be characterized as expansive, relatively unvegetated, and flat. The industrial park is surrounded by upland areas on the south-southeast side, including several small forested hills near Pond Street, and low lying wetland areas on the western, northern, and northeastern side of the Site. At the present time, 17% (79 acres) of the Site is classified as wetlands as discussed in the ecological characterization report (M&E 1995).

The topographic relief of the Site is approximately 50 feet, with the highest elevation of approximately 150 feet on the eastern side of the Site and the lowest of approximately 100 feet on the northeast side near the B&M Pond. Other significant topographic features include several disposal areas which contain a mixture of vegetative cover (M&E 1995). These disposal areas are further discussed in sections 3.2.2.2 and 3.2.2.3.

3.1.3 Soils

Soils on and in the immediate vicinity of the Site are classified as predominantly urban land with other soil types to a lesser extent including the Freetown muck, ponded Freetown muck, Swansea muck, Udorthents-wet substratum, Udorthents-urban land complex, Windsor loamy sand, Wareham loamy sand, Deerfield loamy sand, and Montauk loamy sand (MCD, 1986). Soil types occurring in the vicinity of the Site are shown in Figure 3-1.

Urban land is indicated in areas where the soil has been disturbed or altered or is obscured by buildings, industrial areas, paved parking lots, sidewalks, roads, and railroad yards and where these features cover more than 75% of the surface area (Figure 3-1). The Iron Horse Industrial Park portion of the Site (main railyard and industrial buildings) is designated as urban land.

The Freetown muck consists of nearly level, very poorly drained organic soils that occur in depressions and on flat areas of uplands and glacial outwash plains. The Freetown muck has been mapped on the eastern side of the Site and corresponds to low-lying areas near the channel of the unnamed stream and the area presently occupied by the B&M Railroad Landfill. The B&M Railroad Landfill is a former wetland area that was landfilled and the Freetown muck corresponds to peat encountered in borings drilled in that location. The Freetown muck also occurs in most of the area occupied by the B&M Locomotive Shop Disposal Area B.

The ponded Freetown muck consists of Freetown muck soils that are covered by 1 to 3 feet of water most of the year and are associated with marsh vegetation. On the Site, the occurrence of ponded Freetown muck corresponds with the B&M Pond.

The Swansea muck is present in the barge turnout area just north of the Middlesex Canal on the west side of the Site. The Swansea muck consists of nearly level, deep (more than 5 feet), very poorly drained organic soils that occur in depressions and low, flat areas of uplands and in glacial outwash plains and terraces. Swansea series soils have a water table that is at or near the surface most of the year.

The Udorthents-wet substratum consists of gently sloping areas that were once floodplains or swamps but have subsequently been filled in. The presence of Udorthents-wet substratum on the eastern side of the Site, in the vicinity of the RSI Landfill and the Johns-Manville Asbestos Landfill, indicates that portions of these areas were former wetlands. This soil type is also present on the northwest side of the Site, across the Middlesex Canal and east and west of the turning basins (MCD, 1989).

An Udorthents-urban land complex occurs just to the southeast of the Site and consists of areas from which soil has been excavated or deposited due to construction operations. These areas have been disturbed to the extent that natural soils are no longer recognizable and are no longer a major factor in determining the limitations or capabilities of the land.

The Windsor loamy sands consist of nearly level to very steep, deep (more than 5 feet), excessively drained, loose, sandy soils that formed on glacial outwash plains, terraces, deltas, and escarpments. Windsor soils occur in two locations on the Site, near High Street on the west side of the Site and along Pond Street on the east side of the Site.

The Wareham loamy sand consists of poorly drained soils of very friable or loose, loamy fine sand which generally form in sandy glacial outwash. Where it occurs, the topography is generally level to gently sloping. Wareham loamy sand is present on the western side of the Site and corresponds to the location of a series of interconnected small ponds that drain toward the Middlesex Canal.

The Deerfield loamy sand consists of gently sloping, deep (more than 5 feet), moderately well-drained soils that formed on sand deposits such as glacial outwash plains, terraces and deltas.

Deerfield soils are characterized as having rapid to very rapid permeabilities. Deerfield loamy sand soils occur in two locations on the Site, along the Middlesex Canal near the Asbestos Lagoons and along Pond Street.

The Montauk sandy loam consists of nearly level to steep, well drained soils that form on the tops of drumlins and in compact glacial till. These soils have a friable fine sandy loam surface soil and subsoil that have moderate or moderately rapid permeability overlying a substratum of firm loamy coarse sand to sandy loam with moderately low permeability. Montauk soils have a very stony surface and subsurface. Montauk sandy loam is present on the southern side of the Site just south of the B&M Locomotive Shop Disposal Area B.

3.1.4 Demographics and Land Use

The Site is located within the town of Billerica, in Middlesex County, Massachusetts. The Tewksbury, Massachusetts, town line is approximately 0.25 mile to the northeast of the Site boundary. Most of the town of Billerica, much of Tewksbury, and small areas of Chelmsford, Lowell, and Wilmington, Massachusetts, are within 3 miles of the Site. The village of North Billerica is approximately 0.5 mile to the northwest, while the center of Lowell is about 4 miles to the northwest.

3.1.4.1 Demographics. In 1990, the population of Billerica was 37,609. This exceeded the 1980 population of 36,727 by only 2%. The growth rate of the town's population has slowed considerably since the 1960s, when there was a 77% increase in 10 years. Based on the 1990 population, the average population density of the town was 1,452 persons per square mile. The per capita income was $16,395.

The population of Tewksbury in 1990 was 27,266. This represents an 11% increase over the 1980 population of 24,635. The population density was 1,317 per square mile in 1990, or slightly lower than that of Billerica.

Both Tewksbury and Billerica are within the Lowell, Massachusetts-New Hampshire Standard Metropolitan Statistical Area. Based on the combined town populations, over 60,000 people live within 3 miles of the Site. Approximately 1,000 people live within 0.25 mile of the Site, based on the population density of the area. The age structures of the populations within 3 miles and within 1 mile of the Site are both described in CDM's Phase I RI report (1987).

3.1.4.2 Land Use. Land use within the Site and in the immediate vicinity is illustrated in Figure 3-2. The Site is used for industrial purposes, with no residential use. There are wetlands within the Site. The Middlesex Canal is essentially impassible for recreational or economic purposes. Some parts of the Site are fenced, but most is accessible to passers-by.

The area within 1 mile of the site boundary is primarily forest and residential. Land use categories identified in Billerica and Tewksbury in 1987 were industrial use, residential use, commercial use, institutional use, open wetland, forested wetland, and open water (CDM, 1987). This corresponds well with uses mapped by the Massachusetts Geographic Information System (MGIS). An area across the railroad tracks from the northwest corner of the Site is used for recreation, specifically as a baseball field. Other land near the Site study area has commercial and light industrial uses; wooded wetlands are also present.

The areas closest to the Site are mostly single-family residential properties. Some multiple family residences, condominiums, and mobile homes are also in the area (CDM, 1987).

Institutional uses include potential sensitive receptors identified in CDM's Phase 1A RI report (1987). These consist of four child care centers within 1 mile of the Site: Faulkner Kindergarten across the Concord River in North Billerica, Arey Country Day School near Billerica Center, Red Barn Nursery School on Pond Street in Billerica, and Tewksbury Youth Center at the corner of Whipple and Pine Streets in Tewksbury.

Commercial land use is concentrated along Route 3A in Billerica, which has extensive retail development. The Purity Supreme warehouse abuts the Site to the south. There are ongoing industrial uses within the site boundaries. Companies operating in 1987 included General Latex, Spincraft, the B&M Railroad, Penn Culvert, and the McQuestern Lumber Company.

According to CDM's Phase 1A RI report (1987), several areas surrounding the Site are used for recreation. Long Pond, just over the Tewksbury town line, is used for ice fishing in the winter and fishing and swimming in the summer (CDM, 1987). The Concord River, to the west of the Site study area, is also used for fishing. The Billerica Rod and Gun Club is located on Pond Street. Hunting for rabbits and other small game occurs in wooded areas adjacent to the Site (CDM, 1987). The use of dirt bikes and snowmobiles near the Site have been reported (CDM, 1987). Two playing fields are located within 1 mile of the Site, including a field across the High Street Bridge from the Site and a field adjacent to the Marshall Middle School.

There are small, protected, open-space properties approximately 500 feet from the Site, including one property near High Street to the northwest and a property near Salem Street to the southwest. The Phase 1A RI report (CDM, 1987) identified a farm on Oak Street, which is located within 1.2 mile to the north of the Site.

Figure 3-3 shows an excerpt of the January 1990 update to the Billerica town zoning map (Town of Billerica, 1953), which identifies the study area as industrial, with a small section of commercially zoned land towards the southwest corner. The industrial zoning extends beyond the site limits along Salem Road, along High Road, and along the B&M tracks. The surrounding area consists of rural residence and neighborhood residence zoning categories with a few small areas of general business zoning and one area of garden-style apartment and townhouse zoning near Route 3A.

Surface waters in the vicinity of the Shaffer landfill are classified as Class B waters by the Commonwealth of Massachusetts and are designated for use as warm water fisheries and for contact recreation (CDM, 1991).

3.1.5 Cultural Resources

Billerica, incorporated in 1655 as "Billirikeyca", was an agricultural village for early colonists. A woolen mill and industrial processes, including leather splitting, cabinet making, and chemical manufacturing, were begun in the first half of the 19th century. Suburban development was widespread in the second half of the 20th century.

The Middlesex Canal, linking the Merrimack River to the Boston basin, runs through the Site study area, and some of its original features remain. However, the channel from a point near the asbestos lagoons to a point near the B&M Railroad Landfill is not the original location of the canal. Construction began in 1794 and was completed in 1803. The canal was funded by private subscription and built by private contractors, including owners of farms along the route (Clarke, 1974). The canal at the Site is part of a four-mile level stretch extending from the Concord River Millpond at North Billerica to locks in Wilmington, just east of the aqueduct over the Shawsheen River; a single stop gate controlled water flow along this stretch (MCA,1967). Histories of the canal indicate that clay was used along the canal banks to limit seepage of the canal water into neighboring lower lands (Clarke, 1974). However, use of the clay liner in the canal may have been inconsistent.

Canal boats and rafts were 9 to 9.5 feet wide and were permitted to be between 40 and 75 feet long (Clarke, 1974). These boats were towed by horses or oxen. Although the canal was mainly used for commerce, a holiday passenger boat also used the canal in the 1830s, and skaters could go from Charlestown to Lowell in the winter (Clarke, 1974). In 1835, the Boston and Lowell Railroad was completed approximately parallel to the canal.

Five historic sites in Billerica have been listed on the National Register of Historic Places: Sabbath Day House, the Billerica Town Common Historic District, the Middlesex Canal, the Billerica Mills Historic District (also known as the Talbot and Faulkner Mills Historic District), and Manning Manse (CDM, 1987). The Billerica Mills Historic District, in North Billerica, and the Billerica Town Common Historic District and the Sabbath Day House, located near the center of town, are each approximately 1 mile from the Site. The Manning Manse, located to the west of Route 3A, is more than 1 mile from the Site.

The Massachusetts Historical Commission (MHC) maintains the State Register of Historic Places, which overlaps with the National Register of Historic Places. Places near the Site that are listed on the state list, other than those described above, include the Billerica Center Historic District, which extends out from the Billerica Town Common District. Also near the Site is the Corner Historic District, at the corner of Salem Road and Pollard Street within 0.25 mile to the west.

A town inventory of historical properties revealed two additional historical assets within the site boundaries (CDM, 1987). The Small Pox Cemetery, dating back to 1811, is located between the Middlesex Canal and the commuter rail line. The Content Brook Mill is at the eastern end of the Shaffer Landfill property.

Files on five additional locations within or adjacent to the Site are maintained at the MHC. These include the Pond Street bridge over the B&M Railroad at the site boundary (inventoried as BIL.917), although the bridge is not noted for unusual features of historical interest. The B&M RR Billerica Shop Complex (BIL.299), the Equipment Storage Shed (BIL.300), the Maintenance Shed (BIL.301), and the Power Plant (BIL.302) are centrally located on the Site. These buildings were constructed between 1911 and 1914, and each was recommended as eligible for the National Register during an MBTA Historical Property Survey conducted in 1988, as noted in MHC files. Also, a prehistoric archaeological site, identified by the MHC as No. 19-MD-36, is located in the area. Because the Inventory of Archaeological Assets is considered confidential by the MHC, the exact location of site No. 19-MD-36 is not indicated here.

3.1.6 Groundwater Resources

The MGIS has mapped a variety of resources in the state, including water-related resources. As shown in Figure 3-4, part of the Site overlies what is expected to be a medium-yield aquifer; the remainder is expected to be a low-yield aquifer. No public water supply sources are located within the medium-yield aquifer on the Site. The Massachusetts Contingency Plan defines groundwater that may be used as a drinking water source, specifically including groundwater in a high- or medium-yield aquifer (i.e., Potentially Productive Aquifer), as class GW-1. Groundwater that may discharge to surface water, considered to include all groundwater in the state, is class GW-3. Based on these criteria, groundwater underlying the Site is classified as GW-1 and GW-3. However, since the Site is over 100 acres in size and meets the industrial use criteria, it could be reclassified as a non-potential drinking water source area (NPDWSA) as described in the Massachusetts Contingency Plan and MADEP policy WSC-97-701. Future reclassification of groundwater may occur based on this criteria. Although, as of the latest MGIS update of September 1996, the hellhead protection and medium yield aquifer areas have remained unchanged.

Although not currently in use, groundwater source locations for community public water supplies are located less than 1 mile east of the Site in Tewksbury. The ½-mile Interim Wellhead Protection Area (IWPA) for one of the Tewksbury wells extends into the Site approximately 500 feet northeast of the site boundary (Figure 3-4). Surface water and other groundwater source locations for community public water supplies are located at North Billerica on the Concord River, just north of the Route 3A bridge. where a filtration plant is located. The southwestern corner of the Site is close to the ½-mile IWPA for the North Billerica well (Figure 3-4). However, this well is not currently in use either.

There may be private wells along Gray Street, which is east of the Shaffer Landfill section of the Site, based on the knowledge of local personnel at the Billerica Health Department (M&E, 1996). The town of Billerica does not maintain records for these wells, if they do exist. It is not known whether any such private wells are used as sources of drinking water or water for other domestic uses.

3.2 GEOLOGY

This section describes the regional geologic setting in which the Site is situated, the geology of the Site, and the geology of the five individual areas of concern at the Site.

3.2.1 Regional Geology

The following section is a discussion of the regional geology of the Site, which includes the regional tectonic setting, bedrock stratigraphy and structure, bedrock geochemistry, and development of the surficial geology (glacial history).

3.2.1.1 Regional Bedrock and Tectonic Setting. Regional bedrock in northeastern Massachusetts is sub-divided into three northeast-trending structural provinces that are lithologically distinct and generally bounded by major fault zones. Each terrane represents a distinct crustal block that is not correlative with adjacent terranes because no geologic units can be recognized between them (Zartman and Naylor, 1984; Nelson, 1987; Hill et al., 1984; Hepburn et al., 1993). The tectonic setting of the Site is shown in Figure 3-5.

The Site lies within the Nashoba Terrane or Nashoba Zone, a separate lithotectonic zone trending northeast-southwest across Connecticut and eastern Massachusetts. The Nashoba Zone, along with the Boston-Avalon Terrane to the southeast, compose the eastern margin of the Appalachian orogen in southeastern New England (Hepburn et al., 1993). The Nashoba Zone is bounded to the northwest by the Clinton-Newbury Fault which separates the Nashoba Zone from the Eastern Merrimack Terrane, and by the Bloody Bluff Fault on the southeast, which separates the Nashoba Zone from the Boston-Avalon Terrane (Hill et al., 1984; Nelson, 1987; Hepburn et al., 1993). The Bloody Bluff fault zone is a major fracture-suture zone in eastern New England extending from Connecticut to the Gulf of Maine. The fault zone forms an extensive regional lineament that is recognized in the topography as a series of aligned but discontinuous streams and valleys (Nelson, 1987).

The Nashoba Zone is believed to have formed in an island arc or marginal basin environment in the Lower Paleozoic era and consists of mostly mafic volcanic rocks and volcanogenic sedimentary rocks. During the Ordovician-Silurian periods, these rocks were intruded extensively by calc-alkaline intermediate and granitic magmas and were deformed and metamorphosed to high grade during the Silurian. The Ordovician and Silurian-aged calc-alkaline intermediate plutonism in the

Nashoba Zone may be related to the presence of an eastward-dipping subduction zone that was beneath both it and the Eastern Merrimack Terrane to the north (Hepburn et. al, 1993).

Stratigraphy. Figure 3-5 is a map showing the regional bedrock geology in the vicinity of the Site. The Nashoba Zone is composed of mostly Cambrian and Ordovician-aged, stratified (sedimentary and volcanic) rocks that were deposited in a marine environment and regionally metamorphosed and polydeformed in the Ordovician-Silurian. Stratified rocks of the Nashoba Zone are mainly composed of metasediments and amphibolites that have been metamorphosed to mid- to upper-amphibolite grade facies. Stratified rock units that comprise the western portion of the Nashoba Zone include the Tadmuck Brook Schist, schists and gneisses of the Nashoba Formation and the Fish Brook Gneiss. The eastern portion of the Nashoba Terrane is composed primarily of the Marlboro Formation, a thick amphibolite sequence of basaltic origin (Hill et al., 1984).

From the mid-Ordovician through at least the Silurian, the stratified rocks described above experienced widespread plutonism of contemporaneous calc-alkaline intermediate and granitic magmas (Hepburn et al., 1993). Approximately half of the Nashoba Zone is underlain by igneous or metaigneous rocks (Hill et al., 1984). Intermediate composition plutons in the Nashoba Zone have been mapped as the Straw Hollow Diorite, the Assabet Quartz Diorite, and the Sharpner's Pond Diorite. These units range in composition from gabbros cumulates to hornblende and hornblende-biotite diorites and tonalites (Hepburn et al., 1993).

Granitic rocks intruding the Nashoba Zone are represented by the Andover Granite, which extends over much of the southwestern portion of the terrane. The Andover Granite may have formed partially as the result of anatexis or the remelting of preexisting sedimentary rocks. The Andover Granite has been divided into six different facies on the basis of mineralogical and textural criteria (Castle, 1964). However, two fundamental units are generally recognized. The Type 1 Andover Granite is described as a mildly peraluminous biotite-muscovite granite, while the Type II Andover Granite is described as a strongly peraluminous muscovite-garnet granite (Hill et al., 1984). Type I may predate Type II by some 40 million years (Rast and Skehan, 1993).

Radiometric dates provide estimates of the ages of the lithologies that make up the Nashoba Zone and the major metamorphic events that deformed them. The oldest lithology is the Fish Brook Gneiss with an age of 520 +14/-11 million years before the present (Ma) (Hepburn et al., 1993), followed by the Sharpner's Pond Diorite with a reported age of 430 Ma (Zartman and Naylor, 1984). Metamorphism of the Nashoba Terrane occurred at 425 Ma, as indicated by dates from metamorphism of the Fish Brook Gneiss. The Andover Granite represents the youngest phase of deformation and metamorphism in the Nashoba Zone, with an age of 412 ± 2 Ma (Hepburn et al., 1993).

Structure. The geologic structure within the Nashoba Zone is described by Barosh (1976) as a northeast-trending, northwest-dipping fault complex with west-over-east and right-lateral components of movement. This broad regional imbricate fault system has significantly affected the distribution of stratigraphic units (Alvord et al., 1976). According to Rast and Skehan (1993), vertical or sub-vertical brittle faulting is most abundant within the Nashoba Zone. The series of finger-like projections of the Andover Granite into stratified rocks of the Nashoba Zone is the result of multiple step faults juxtaposing the granite and the county rock, resulting in an interdigitating pattern. Movement along major faults associated with the Nashoba Zone has been attributed to the Alleghenian orogeny, which occurred in the Carboniferous (Rast and Skehan, 1993).

According to Holland (1980), a bedrock valley which most likely represents the channel of the preglacial Merrimack River, is coincident with the northern portion of the Site.

Geochemistry. The Andover Granite can be sub-divided into six facies: muscovite-granite-gneiss, biotite granite-gneiss, fine grained granite gneiss, undifferentiated granite-gneiss, binary (2 mica) granite, and pegmatitic granite (Castle, 1964). Diorites of the Nashoba Zone range in composition from gabbros to horneblende-diorites and tonalites.

Mineralogically, granites are composed primarily of quartz and feldspar in equal parts with mica as a minor accessory constituent. These minerals consist primarily of silica and aluminum. The following is a breakdown by percentage of these constituents that are considered typical of a granite:

72-73% SiO_2, 13% Al_2O_3, 5% K_2O, 3% Na_2O, and other minor constituents making up less than 2% each, including: Fe_2O_3, FeO, MnO, MgO, CaO, TiO_2, H_2O, and P_2O_5 (Ehlers and Blatt, 1982).

Diorite is an igneous rock containing mafic minerals (plagioclase feldspars and ferromagnesian silicates) with little or no quartz. Diorites generally contain a smaller quartz-to-feldspar ratio than granites, with a higher percentage of mafic minerals as accessory constituents. Geochemically, diorites contain less silica and more aluminum than granites. The following is a breakdown by percentage of the constituents, typical of diorite: 51% SiO_2, 15% Al_2O_3, 8% CaO, 7% FeO, 6% MgO, 3% Na_2O, 3% Fe_2O_3 and other minor constituents making up less than 2% each, including MnO, K_2O, TiO_2, H_2O, and P_2O_5 (Ehlers and Blatt, 1982).

Schist is a type of metamorphic rock which has been largely or completely recrystallized at a moderately high degree of regional metamorphism. Schists are characterized by fine-scale foliation (or layered arrangement) resulting from the parallel disposition of lamellar minerals, most commonly the micas. Schists are formed during metamorphism whereby a parent rock is heated or compressed so that the original constituents of the rock are altered and deformed. Geochemically, schists contain a variety of constituents, dependent on the parent rock from which they were derived prior to metamorphism.

The weathering of granites, diorites and other igneous rocks causes the mineral constituents of the rocks to decompose. Because each mineral constituent has a different atomic composition, some minerals may decompose faster than others under similar conditions. Weathering reactions of granitic igneous rocks begin with the breakdown of aluminum and silica-rich feldspars and micas into aluminum- and silica-rich clay minerals including kaolinite, illite, sericite, and montmorillonite (Ehlers and Blatt, 1982).

3.2.1.2 Regional Surficial Geology. The surficial geology of southeastern New England, including the Site vicinity, is primarily the result of the advance and ablation (retreat) of the last (Wisconsin) glacial stage, which ended approximately 10,000 years ago and resulted in the deposition of various unconsolidated glacial sediments. As in most of New England, the unconsolidated geologic deposits of the site vicinity are attributable to Pleistocene glacial and recent post-glacial processes (Castle, 1959).

During the Wisconsin glaciation, the ice underwent a stagnation zone retreat, which covered the Billerica area with a chain of shallow glacial lakes (Holland, 1980). These lakes were formed by glacial meltwater ponding behind ice dams, which created conditions for intermittent glaciofluvial and glaciolacustrine depositional environments as the ice dams ponded and released glacial meltwater. The two largest glacial lakes situated in the Billerica Quadrangle were Glacial Lake Shawsheen, which covered portions of the northern half of the quadrangle, and Glacial Lake Concord, which covered portions of the southern half.

The surficial geology in the vicinity of the Site is shown in Figure 3-6. The recognition of two types of till is generally considered to be direct evidence of only one glaciation. Two type of till are associated with the Billerica area, although two and possibly three glaciations are thought to have occurred in the area during the Wisconsin glacial stage. Both tills found in the Billerica area are characteristically nonsorted to poorly sorted and contain only isolated pockets of washed gravel. In Figure 3-6, exposed till deposits are shown as undifferentiated and occur primarily in the southwest corner of the Site.

The basal till in the Billerica area is described as a silt and clay-rich, blocky, sometimes fissile, boulder-rich compact till which weathers deeply to a rich chocolate brown color. Below the weathered zone, the basal till tends to be medium gray in color (Holland, 1980). Basal or lodgement till generally accumulates under the glacier and is incorporated into the ice during glacial advance. Later, when partial melting of the ice occurs due to heat generated by the glacier's movement, basal till can be subglacially deposited onto bedrock. Basal till deposits are characterized as firm and compact and contain a high percentage of fines because they are accumulated under high pressure conditions beneath the glacial ice.

The upper or ablation till in the Billerica area, which may directly overlie bedrock where the basal till is absent, is described as sandy, boulder-rich, non-fissile, loose, and generally weathered to shallow depths of several feet. The weathered ablation till is uniformly tan while the unweathered ablation till is light tannish gray (Holland, 1980). The deposition of ablation till is associated with the retreat of the glaciers, which results in the accumulation of sediments on the surface of the ice during melting. Sediments off the glacier are transported and deposited by debris flows or running water from glacial melt. Ablation till, generally found superimposed onto basal till, is less dense than basal till because the sediment contains coarser-grained materials and was deposited during sloughing or wasting processes.

Stratified drift or glacial outwash deposits are found within and are exposed at the surface of the Billerica Quadrangle. These deposits are described as being composed almost exclusively of materials coarser than fine to medium sand, with a few exceptions of exposures of lake bottom sediments consisting of silty sand. As shown in Figure 3-6, these deposits are associated with Glacial Lake Concord, Glacial Lake Shawsheen or smaller glacial lakes in the area. Stratified drift deposits nearest the Site were deposited in the area formerly covered by Glacial Lake Shawsheen. Except for glacial till exposed in the southwest corner, the Site is primarily underlain by stratified drift that was deposited along the Concord River at a time when it was situated farther east than its current channel (Holland, 1980).

Outwash deposits are created when running water on the glacier's surface transports superglacial sediments off the ice, depositing them in front of the glacier under steady-state flow conditions. These conditions can produce well-graded and well-sorted deposits that generally lack finer materials. Outwash deposit, a type of glaciofluvial deposits, may overlie other glacial deposits.

Recent sediments were deposited post-glacially and include local alluvium swamp sediments and stream terrace sediments. Localized deposits of alluvium are found along many small streams. Swamps occupy many lowland areas, including depressions and the marginal areas along many streams. Organic materials most likely began to accumulate in many swamps shortly after the retreat of the ice, resulting in peat deposits. Stream terrace deposits may have originated from erosion or deposition (Castle, 1959). In the general vicinity of the Site (Figure 3-6), recent alluvium and stream terrace deposits are associated locally with the Concord River while swamp deposits occur throughout the area.

3.2.2 Site Geology

Interpretations of the Site geology are based on field observations made during this RI and data previously collected during the Phase 1A RI (CDM, 1987).

3.2.2.1 Site Bedrock Geology. Site-wide and area-specific cross-sections (Figures 3-10 to 3-12 and 3-14 to 3-19) were constructed based on geologic logs recorded during this RI and previous investigations as referenced in section 1.0. The orientation of the two site-wide cross-sections, A to A' and B to B', are shown in Figure 3-10. These cross-sections are presented in Figures 3-11 and 3-12. Geologic logs are included in Appendix D.

Bedrock Lithologies. Bedrock encountered during the installation of the MW-series monitoring wells as well as available data from previous investigations, provided the basis for interpreting bedrock geology underlying the Site. A bedrock geologic map, presented in Figure 3-7, was drawn using drill cutting logs from the MW-series monitoring wells and coring logs from the OW-series monitoring wells.

Bedrock underlying the Site is comprised of three distinct lithologies including granite, schist, and diorite. Migmatite, which is an incompletely granitized rock with a mixed appearance, may also be present in some locations in the contact zone between the granite and the schist.

Granite, interpreted to be the Andover Granite, was found to underlie most of the central, eastern, and southeastern portions of the Site. The occurrence of granite corresponds to a ridge in the bedrock surface in the south and east portions of the Site (Figure 3-8), the highest part of which is exposed in outcrops near Pond Street. The granite outcrops near Pond Street are the only known bedrock outcrops on the Site, except for a few apparently isolated exposures of granite observed in the RSI Landfill. Cuttings logged during the installation of some of the MW-series bedrock monitoring wells contained quartz, feldspar, and mica, which are the principal mineralogical constituents of granite. At several locations, the granite was observed to be pegmatitic (coarse-grained) since large flakes (greater than 2 cm) of biotite and muscovite were observed. Cores logged from the OW-series wells also indicate the occurrence of granite (quartz, mica and feldspar) that was sometimes observed to be pegmatitic.

Schist was encountered in several bedrock boreholes and is presumed to underlie the north central part of the Site as well as north of Shaffer Landfill (GHR, 1988). The schist, which was logged as gray or greenish schist and is interpreted to represent the Nashoba Formation, underlies more low-lying portions on and near the Site such as the Middlesex Canal and Richardson Pond. This suggests that the difference in resistance to weathering between the schist and the granite, with the schist being less resistive, may to some extent control the topography of the Site area. No outcrops of the Nashoba Formation (schist) were observed on the Site.

Diorite and granodiorite were encountered in several bedrock boreholes in the southwestern portion of the Site. Granodiorite is intermediate in composition between a granite and a diorite. The occurrence of diorite and granodiorite on the Site suggests a tabular-shaped pluton as shown in Figure 3-7. The pluton is most likely part of the Sharpner's Pond Diorite or the Straw Hollow Diorite.

Site Bedrock Topography. Figure 3-8 is a bedrock-surface contour map generated using elevations at which the top of bedrock was encountered in the OW-series and MW-series monitoring wells. The depth to bedrock encountered in the MW-series monitoring wells ranged from 13 to 85 feet below ground surface. The distribution of bedrock elevations throughout the Site indicates that the bedrock surface tends to be higher in the southern and southeastern portions of the Site, lower in the northern and western parts of the Site, and it corresponds generally to changes in bedrock lithology.

The two tills consist of a lower (basal) till that was deposited 40,000 to 50,000 years ago and an upper (ablation) till that was deposited 13,800 to 13,200 years ago (Holland, 1980). Contoured bedrock surface elevations shown in Figure 3-8, suggest the presence of a trough in the bedrock surface trending northeast and then northwest across the Site. If present, the trough may represent the channel of a pre-glacial tributary to the Merrimack, which flowed just to the north of the Site (Holland, 1980).

The higher elevations shown in Figure 3-8 correspond with the occurrence of the Andover Granite noted on the Site and suggest a bedrock ridge. The ridge trends approximately north-northeast and outcrops near Pond Street and just south of the RSI Landfill.

A weathered bedrock zone was encountered in 10 of the 15 MW-series monitoring wells. The weathered zone ranged from a minimum thickness of 1 foot at the MW-205 cluster to a maximum thickness of 20 feet at MW-207B. The occurrence of the weathered zone was not limited to a particular bedrock type since it was encountered in all three lithologies. Nine of eleven bedrock wells installed coincident with the inferred bedrock trough contained a weathered zone. Four of the eleven wells contained a weathered zone greater than 5 feet in thickness, which may indicate increased subaerial exposure, decreased glacial erosion, increased fractured or different minerological composition at those locations.

Bedrock Structure. No bedrock faults are known to occur on the Site. Bedrock outcrops were observed to be jointed and cuttings and core obtained from bedrock monitoring wells indicate the bedrock is fractured.

In an effort to determine potential flow directions in the fractured bedrock underlying the Site, the attitude of joints were measured at outcrops near the Site. Outcrops in the Andover Granite on the east end of the Site and across Pond Street were measured as well as one outcrop of the schist along High Street just west of the Site.

Rose diagrams shown in Figure 3-9 depict the orientations of joints in the granite outcrops, schist outcrops, and all outcrops measured. The joints measured in the schist demonstrate a dominant fracture set striking predominantly N55E to N65E (northeast) which is parallel to the direction of foliation also measured in the outcrop. A subdominant set oriented approximately northwest is also apparent.

Joints measured in the granite outcrops exhibit more diversity in directions, but a larger population was measured. Granite joints show a dominant fracture set striking approximately N10E to N30E or north-northeast. Two subdominant fracture sets, one striking east-west and the other striking northwest-southeast, are also present. A less dominant set striking northwest is also indicated.

A comparison of the rose diagram which shows strikes of joints for all outcrops measured with those of the two separate lithologies suggests that joint patterns are different between the granite and the schist. Only the less dominant northwest direction appears to be common between the two sets.

In summary, joints measured in the Andover Granite suggest bedrock fractures would be oriented primarily north-northeast, with a secondary set oriented approximately east-west. Bedrock fractures in the Nashoba Formation would most likely be oriented northeast.

3.2.2.2 Site Surficial Geology. The thickness of the overburden on the Site ranges from 0 to 85 feet and because the Site is relatively flat, corresponds in general to topographic trends in the bedrock surface. The overburden was found to consist of glacial drift deposits, overlain locally by recent swamp deposits (peat) and by fill deposits that are the result of disposal and construction activities.

The overburden was found to be thinnest in the southeastern corner of the Site (10 feet at the OW-05/06 cluster) and in the southeastern corner of the RSI Landfill (12.5 feet at the MW-210 cluster). It appears to be thickest in the center of the Site between the southwestern corner of the RSI Landfill (85 feet at MW-207B) and in the Old B&M Oil/Sludge Recycling Area (73 feet at the MW-202 cluster). These two areas correspond with the trough in the bedrock surface discussed in the previous section.

The overburden consists of primarily glacial drift deposits including basal and ablation till and glacial outwash deposits. Basal till was found primarily on the southwestern side of the Site underlying the Old B&M Oil/Sludge Disposal Area and the B&M Locomotive/Shop Disposal Areas. Where encountered, the basal till was generally described as gray, dense, poorly sorted, and consisting of silty fine-to-coarse sand with some clay and trace amounts of fine gravel. According to geotechnical analyses on samples of the basal till, the average grain-size distribution consisted of 20.6% clay, 27% silt, 33.6% sand, and 18.8% gravel.

The thickness of the basal till ranged from 10 to 33.5 feet. Because of the predominance of fine-grained materials and the density of the basal till unit, it may, where present, act as a confining unit for bedrock groundwater.

Ablation till was found primarily in the western and southern side of the Site, generally overlying basal till. The ablation till was identified as being less dense than the basal till and contained a higher percentage of coarse-grained (sand and gravel) particles. The ablation till generally consisted of a brown/tan, silty, fine-to-coarse sand with traces of clay and fine gravel. Geotechnical analyses of samples of the ablation till indicated that the average grain size distribution consisted of 2.5% clay, 39.5% silt, 60.5% sand and 11.5 % gravel (Table 3-1).

Glacial outwash deposits were encountered at nearly all of the monitoring well locations. Where encountered, glacial outwash was described as consisting primarily of tan or gray, fine-to-coarse sand with gravel and, in some cases, significant quantities of silt. The average grain-size distribution of glacial outwash at the Site consisted of 2.6% clay, 20.6% silt, 80.2% sand and 8.8% gravel according to geotechnical analyses. Outwash sediments ranged in thickness from 4 feet at the MW-210 cluster to 56 feet at MW-207B and in general were found to become coarser with depth. The thickest outwash deposits (more than 30 feet) were found in the central part of the Site coincident with the bedrock valley in the Old B&M Oil/Sludge Recycling Area, in the vicinity of the Asbestos Lagoons, and in the Contaminated Soil Area. The glacial outwash deposits are particularly well sorted in the central portion of the Site.

Recent Deposits. Quaternary (recent) surficial geology at the Site was influenced by the development of streams, ponds, and wetlands, which have produced deposits of alluvium and peat which overlie the glacial deposits.

Peat is formed as the result of the accumulation of decaying organic matter found in depressed areas such as ponds and wetlands. Peat deposits were encountered underlying fill or natural materials in the B&M Railroad Landfill, the Old B&M Oil/Sludge Recycling Area, and the Contaminated Soil Area. Peat deposits, recorded in some borings at depths of several feet below the ground surface, suggest that previously existing wetland areas were subsequently filled in, either naturally or due to construction or disposal activities. The thickest peat deposits were encountered in the B&M Railroad Landfill (18 feet at the MW-214 cluster).

Discussions of area-specific geology, including various fill materials encountered at the Site during the RI, are presented below by area of concern.

3.2.2.3 Area Specific Geology. Various landfilling operations in each of the five areas of concern have resulted in the interaction of debris and waste materials with the natural geologic materials. This section describes the area-specific surficial and bedrock geology of the five areas, including the landfilled materials and presents six area-specific geologic cross-sections. Cross-section transect locations are shown in Figure 3-10. Area-specific cross-sections are shown in Figures 3-11 and 3-12, and 3-14 through 3-19.

The results of geophysical surveys conducted in four of the five areas of concern (B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, and the Old B&M Oil/Sludge Recycling Area) delineated the approximate horizontal subsurface limits of previous landfilling and disposal activities and indicated the potential locations of buried metallic objects. Data from soil borings and test pits confirmed the approximate source area boundaries as delineated by the geophysical data, identified or verified sources of geophysical anomalies, and provided information regarding the surficial geology in each of the areas investigated. Additional subsurface data on area-specific geology including bedrock geology were obtained during this investigation with the installation of piezometers and monitoring well clusters. Descriptions of fill materials in the various landfills, which tend to be distinctive from one landfill to another, as well as natural materials, are based on test pit excavations and split-spoon soil samples collected during soil borings and monitoring well installations. The approximate limits of these materials in each of the five areas of concern are shown in Figure 3-13. The surficial and bedrock geology of each of the five areas of concern are discussed below.

B&M Railroad Landfill. The B&M Railroad Landfill area is a broad lowland at the northeast corner of the Site. It is bordered by the B&M Pond and a wetland area on the east side, a wetland area and the Middlesex Canal on the south side, and an intermittent drainage swale on the north side. Fill materials consisting of metal and wooden debris covering approximately 14 acres were observed to extend to the edges of surrounding surface water bodies. The fill materials are underlain by peat and glacial outwash deposits. The landfill is thickly overgrown with vegetation; however, refuse and partially buried debris, including locomotive engine parts, building materials, and abandoned vehicles, are exposed on the surface throughout the disposal area. Bedrock underlying the disposal area was found to be consistently weathered granite, interpreted to be the Andover Granite. The surficial and bedrock geology at the landfill is summarized in cross-section C-C' (Figure 3-14.)

The results of EM surveys conducted in the landfill (August 1993) indicate that fill materials occupy the subsurface of the entire landfill, as evidenced by EM anomalies throughout the survey area. The landfill is bounded by surface water bodies except on the northwest side. The northwestern boundary of the landfill, which is approximately parallel to the railroad spur, was delineated by EM data. The eastern and southern boundaries of the landfill consist of the B&M Pond and associated wetlands and the Middlesex Canal, respectively. The EM data indicated that buried metallic debris may be more concentrated in the northwest and southeast portions of the landfill. Geophysical survey data is included as Appendix C.

In addition to the EM survey, 22 GPR traverses were made to further investigate EM anomalies that were potentially indicative of buried metallic objects. In the southwestern corner of the landfill. a series of flat GPR reflectors suggested the presence of flat packed-earth at a shallow depth below the ground surface. Throughout the landfill, the GPR records were characterized by high amplitude, ringing reflections typically caused by metallic objects, and in some cases, the reflections appeared to be caused by several objects at shallow depths.

The data also suggested that the landfilled materials exist below the water table, which was noted at approximate depths of 4 to 15 feet below ground surface.

Types of fill materials encountered in soil borings and test pits at the B&M Railroad Landfill included railroad and construction debris (railroad ties, brick, concrete, wood, metal, and tar paper), 55-gallon drums (deteriorated and empty), coal, tires, paper, and cloth. Organic vapor readings collected with a PID during soil borings and test pit excavations ranged from 0 to greater than 10,000 ppm in the soil borings and from 0 to greater than 1,000 ppm in the test pits.

Peat deposits encountered under the fill materials in much of the B&M Landfill indicate that the landfill occupies the former northwestern edge of the large wetland area at the northeast end of the Site. Peat deposits were found to be thickest at the eastern edge of the landfill near the B&M Pond (18 feet at the MW-214 cluster) and at the southeastern corner of the landfill near the Middlesex Canal (14 feet at the MW-213 cluster). Boring logs from the western and northern portions of the landfill suggest that the peat pinches out in those directions and that glacial outwash is present.

Glacial outwash deposits underlie the peat, where present, in the landfill and otherwise underlie fill materials. The outwash deposits range from 30 to 50 feet in thickness along the eastern edge of the landfill, thickening to the north and coincident with the thinning of the peat. No data are available on the thickness of the outwash deposits on the western edge of the landfill, but the log for OW-34, several hundred feet southwest of the landfill (CDM, 1987), indicates glacial till (basal and ablation) overlain by 15 feet of outwash.

Bedrock directly underlies the outwash in the landfill and was encountered at depths of 50 to 53 feet at monitoring well locations along the eastern edge of the landfill. Bedrock surface elevations (approximately 60 feet NGVD) in the landfill are lower than in areas to the west and south. The bedrock surface was weathered at all three monitoring well locations, with the thickness of the weathered zone ranging from 4 to 8 feet. Drilling times indicated that the bedrock is fractured. Cuttings logged indicate that bedrock underlying the landfill consists of granite and granite pegmatite, which is most likely representative of the Andover Granite.

During the drilling of MW-213B at the southeast corner of the landfill, elevated headspace PID readings (20 to 25 ppm) on outwash samples collected from just above the bedrock surface suggested the potential for VOC contamination of groundwater in the deep overburden at that location. As a result, telescoping casing was installed before proceeding with the bedrock well installation and the deep overburden was screened at the interval where the contamination was detected.

Soil samples designated for geotechnical analysis were collected from split spoons from the soil borings and the MW-series monitoring wells as well as from surface soil samples. Results from the laboratory analyses of fill materials from the landfill indicate that the average porosity (calculated using the measured dry density and specific gravity) is 57%, vertical hydraulic conductivity values ranged from 5.9×10^{-6} to 1.5×10^{-3} cm/sec, and organic content ranged from 2.8 to 40%. Grain-size analyses performed on seven samples from the landfill indicate that soils are predominantly sands and sands and gravel, but with higher proportions of silt or silt and clay than would be expected for natural soils found elsewhere on the Site. Average grain-size distributions of outwash at the landfill consist of 2% clay, 25% silt, 61% sand, and 12% gravel. Average grain-size distributions of peat at the landfill consist of 6% clay, 37% silt, 53% sand and 4% gravel.

B&M Railroad Landfill Summary of Conditions. The B&M Railroad Landfill was formerly on the edge of the large wetland area that occupies the northeastern corner of the Site and includes the B&M Pond. Underlying the up to 25 feet of landfill materials are peat deposits in the southern portion of the area. The peat deposits up to 18-feet thick, pinch out to the north and west. Glacial outwash underlies the fill in the north and west portions of the landfill and peat in the south and east portions. Granite bedrock with a weathered zone underlies the landfill at depths of approximately 50 feet below the ground surface.

RSI Landfill. The RSI Landfill was used for the disposal of municipal, commercial/industrial, and construction wastes. The area landfilled is an approximately circular area within glacial outwash deposits, suggesting that the area may have been a borrow pit before it was landfilled.

The landfill is located on a topographically elevated portion of the Site corresponding to the edge of a ridge in the granitic bedrock surface. Bedrock is shallow in the vicinity of the landfill, as evidenced by granite outcrops in the central portion of the area. Bedrock is overlain by glacial outwash deposits ranging in thickness from 11 to 23 feet in the vicinity of the landfill. Geologic conditions in the vicinity of the landfill are summarized in cross-section D-D' (Figure 3-15.)

The subsurface of the landfill was initially characterized by collecting electromagnetic data from 1,729 stations. Terrain conductivity (EM) anomalies were used to delineate the limits of waste within the disposal area and suggested that the disposal area contains abundant metallic objects. In addition to the EM survey, 13 GPR traverses were performed at the landfill to further delineate the locations of buried metal objects. The GPR records indicated changes in patterns of reflections at the transition from fill to natural materials, further delineating the extent of disposal. At stations located in the fill, GPR records showed discontinuous ringing reflections of buried metallic objects.

Soil borings and test pits conducted in the landfill confirmed the geophysical data in delineating the horizontal extent of the landfilled materials. These investigations also indicated that the fill may be as much as 15 feet thick in the central portion of the landfill and that groundwater may be in contact with the disposal materials, as suggested by geologic cross-section G-G' (Figure 3-18). Types of landfilled materials noted in soil borings and test pits included wood, brick, metal, rubber, plastic, coal, glass, and newspaper. The electromagnetic and GPR anomalies, which suggested buried metal objects, were found to be attributable to scrap metal and other metallic objects identified in the test pits such as tire irons, storm drain covers, crushed drums, and steel pipes. Organic vapor readings taken with a PID ranged from 0 to 8 ppm in the soil borings and from 0 to 100 ppm in the test pits.

Natural geologic materials underlying fill materials in the RSI Landfill were determined from soil boring logs drilled during the Hydrogeologic Assessment Report (M&E, 1994a) and the installation of MW-series monitoring wells for this investigation. Depth to bedrock beneath the landfill ranges from 12 feet on the southern side to 23 feet on the eastern side. Just west of the landfill, the bedrock valley underlying the Site trends north-northwest, and the bedrock surface was encountered at a depth of 85 feet at MW-207B. Bedrock was found to be granite, presumably the Andover Granite, in all monitoring wells drilled in the vicinity of the landfill. Bedrock was overlain by glacial outwash deposits consisting of brown-to-gray fine-to-coarse sand with some gravel.

Based on these observations, the bedrock surface underlying the landfill most likely slopes to the west, and the depth to bedrock directly underlying the landfill is 20 to 35 feet below the land surface.

Laboratory analyses of geotechnical samples collected during soil borings and of monitoring well installations indicate that the natural soils encountered in the landfill consist of sand and gravel with small proportions (5 to 8%) of silt and clay. The average porosity of the natural soils was 43%, and organic contents ranged from 0.3 to 0.8%. One sample tested for vertical hydraulic conductivity yielded a value of 7.9×10^{-3} cm/sec. Soil samples analyzed from borings within the fill consisted of sand and gravel with a slightly higher proportion of silt and clay (10 to 12%) than the natural soils. The organic contents ranged from 0.5 to 5%, and the average porosity was 45%. No soil samples from the filled materials were analyzed for vertical hydraulic conductivity. Geotechnical samples collected during the installation of monitoring wells in the landfill indicate an average grain-size distribution for outwash of 10% silt, 52 to 82.5% sand, 15 to 38% gravel. Average grain-size distribution of ablation till was calculated to be 2% clay, 56% silt, 58% sand, and 12% gravel.

> **RSI Landfill Summary of Conditions.** The RSI Landfill is in a topographically elevated portion of the Site. Fill materials, consisting mostly of construction debris up to 15 feet thick, were apparently landfilled in glacial outwash deposits that may have previously been quarried. The glacial outwash deposits overlie granitic bedrock, which shallows toward the eastern edge of the landfill.

B&M Locomotive Shop Disposal Areas. The physiography of the B&M Locomotive Shop Disposal Areas (A and B) is characterized by two landfills separated by a drainage swale that flows into the unnamed brook. The two areas are bordered on the north and south by flat, open, industrial areas and on the east by the unnamed stream, its associated wetlands, a forested area, and an east-west trending canal. Historically, both areas A and B have received waste from the adjacent B&M Locomotive Repair Shop.

Area A is bordered by a paved parking area at its northern end, with several debris piles (tires, wood) located on the edge of the parking lot. Area A consists of a mounded, moderately vegetated disposal area, which is bordered by the drainage swale flowing into the unnamed brook and Area B on the south and by the unnamed brook and a forested upland on the east.

Area B consists of a sparsely vegetated landfill bordered on the north by the drainage swale flowing into the unnamed brook and Area A, on the south by the Purity Supreme warehouse compound, and on the east by wetlands, forested lands, and the east-west trending canal. Subsurface conditions at both areas include disposal materials underlain by a thin sequence of glacial outwash and a thicker sequence of glacial till. The bedrock surface in the vicinity of the B&M Locomotive Shop Disposal Areas, as encountered in borings, appears to be fairly level, at approximately the 85-foot NGVD elevation. The geologic conditions are summarized in cross-section E-E' (Figure 3-16). The two B&M Locomotive Shop Disposal Areas, A and B, were investigated separately.

The EM survey data collected at 161 stations in Area A produced in-phase EM anomalies which suggest the presence of buried metallic debris. A GPR survey was not conducted in Area A because in-phase EM anomalies were attributable to visible, aboveground metal debris. Based on the findings of the geophysical surveys, soil borings and test pits were performed to further investigate the subsurface soil and fill conditions and to verify the results of the geophysical data. Soil boring and test pit logs are provided in Appendix D.

Logs from the soil borings and test pits performed in Area A indicated that fill materials include ash, coal, and wood. In addition, several debris piles containing tires, wood, cloth, scrap metal, and used appliances were found on the surface of Area A. Soil boring samples screened with a PID had readings that ranged from 0 to 2 ppm. No organic vapor readings were recorded for test pit samples contained in Area A.

Based on groundwater elevation data from the piezometers, one MW-series monitoring well cluster (MW-206) was installed downgradient of Area A to further investigate and characterize groundwater quality in the shallow and deep overburden and in bedrock. Four feet of fill, consisting of sand with wood and ash, was encountered at the MW-206 cluster. The fill was underlain by 19 feet of outwash and a 2.5 foot weathered zone above competent bedrock, interpreted to be the pegmatitic facies of the Andover Granite. Geotechnical analyses of one near-surface (0 to 2 feet) soil sample from Area A consisted of sand and silt with a trace of gravel.

EM-data collected at 654 stations in Area B identified two areas of non-metallic fill in the western and southern portions of the surveyed area, and two area of metallic fill in the northern and southern edges of the survey area. The areas of metallic fill were verified by surface metal debris observed during the field work. The GPR survey, consisting of 22 traverses totaling 2,100 feet, was conducted to further investigate the EM anomalies attributable to metallic debris that was not observed at the surface. GPR records of the traverses indicate scattered objects, some of which produced ringing GPR signatures that are typical of buried metallic objects.

Based on the findings of the geophysical surveys, soil borings and test pits were performed to further investigate the subsurface soil and fill conditions and to verify the results of the geophysical data. Soil boring and test pit logs are provided in Appendix D.

Fill materials encountered in Area B included a large piece of cast metal, a large metal spool, brick, metal, wood, asphalt, glass, slag, rubber, plastic, coal, and ash. Soil boring samples screened with a PID had readings that ranged from 0 to 90 ppm. No organic vapor readings were recorded for test pit samples obtained in Area B.

Three PZ-series piezometers were also installed to determine the direction of shallow groundwater flow in Area B. Groundwater was encountered at depths of 6 to 8 feet below the ground surface during installation of the piezometers. Split-spoon samples collected from the Area B piezometers indicate that the subsurface contains a 5- to 14-foot thick zone of fill consisting of silty coarse to fine sand and gravel with some cobbles. In some areas, this fill locally contains refuse consisting of scrap metal and rubber.

Based on groundwater elevation data from the piezometers, two MW-series monitoring well clusters (MW-204 and MW-205 clusters), consisting of a shallow and deep overburden well and a bedrock well, were installed downgradient of Area B to further investigate groundwater quality. Both monitoring wells encountered fill consisting of fine-to-coarse sand with some refuse, including slag, metal, and wood. The fill at both locations was underlain by 4 to 21 feet of glacial outwash and 15 feet of ablation till at the MW-204 cluster. The ablation till is underlain by 16 to 20 feet of basal till. At both wells, the overburden is underlain by granitic bedrock, interpreted to be the Andover Granite, with the pegmatitic facies of the Andover Granite present at the MW-204 cluster. A 4.5-foot-thick zone of weathered bedrock was found to overlie the competent bedrock at the MW-205 cluster.

Geotechnical analyses of soil samples from Area B consisted of sand with minor amounts of gravel and silt/clay. Organic content ranged from 0.7 to 2.5% and the average porosity was 48%. Two samples tested yielded vertical hydraulic conductivity values of 1.7×10^{-3} to 1.8×10^{-3} cm/sec. Average grain-size distributions for geotechnical samples of basal till collected during the installation of the monitoring wells were 4% clay, 18% silt, 27% sand, and 51% gravel. Average grain-size distributions for outwash in Area B were 0 to 1% clay, 15 to 31% silt, 69 to 76% sand and 0 to 8% gravel.

B&M Locomotive Shop Disposal Areas (A and B) Summary of Conditions. Soil-boring, piezometer, and monitoring well logs were used to construct an area-specific cross-section E-E' (Figure 3-16). Geophysical surveys indicated primarily metallic fill in Area A and two main fill areas in Area B. Fill and disposal materials in Area A included ash, coal, and wood, and in Area B primarily construction debris. Fill materials are underlain by outwash, ablation till, and basal till. The overburden is underlain by granitic bedrock, interpreted to be the Andover Granite. At the MW-205 cluster, a 4.5-foot-thick weathered bedrock zone is present above the competent bedrock.

Old B&M Oil/Sludge Recycling Area. The Old B&M Oil/Sludge Recycling Area is a fairly flat, open, sandy area. Oil/sludge was mixed with sandy fill and disposed of when the area was used previously for oil/sludge recycling. The sandy fill and oil/sludge, where present, are underlain by glacial outwash and glacial till. Peat was encountered in several borings, indicating that the area was formerly a swampy low-lying area. Geologic conditions underlying the area are presented in geologic cross-section F-F' (Figure 3-17).

The EM data collected during the 1993 surface geophysical surveys demonstrated terrain conductivity anomalies at the northwestern and southeastern edges of the study area that were interpreted to represent contrasts in electrical conductivity between the buried oil/sludge and naturally occurring subsurface materials. Several areas of possible oil/sludge were delineated by correlating anomalous values of apparent conductivity with stained ground. Although the horizontal extent of buried oil/sludge was delineated on the northern edge of the study area, data from the southern portion suggested that the horizontal extent of the waste is beyond the limits of the study area. The GPR traverses were performed in 1993 and focused in areas of EM in-phase anomalies. The GPR anomalies were characterized by broad, relatively flat, moderate-amplitude reflections in the areas of stained ground at the edges of the survey area and were inferred to be indicative of the buried oil/sludge.

Descriptions of fill materials from soil boring and test pits include black sand, black ash, layers of oily silt and clay, oil-stained soils, free product, black slag, black sand with an oily odor, bricks, wood, glass, and foam. The presence of oil and sludge, delineated by the geophysical surveys, was confirmed by test pits (TP-25, TP-26, and TP-27) and borings (BH-35, BH-40, BH-41, and BH-42). The three elongated test pits verified that the EM anomalies correlated with the presence of oil/sludge in the subsurface. Free product was observed in piezometer P-12, installed by CDM in

1987. Organic vapor readings from PID screening of samples from soil borings and test pits ranged from 0 to 1,000 ppm.

Three PZ-series piezometers (PZ-101 through PZ-103) were installed to determine the direction of shallow groundwater flow in the Old B&M Oil/Sludge Recycling Area. Groundwater was encountered at depths that ranged from approximately 1 to 6 feet below ground surface. Split-spoon samples collected from the piezometers contained from 5 to 10 feet of fill consisting of clay and sand. At PZ-101 and PZ-102 the fill is underlain by natural materials, including outwash at PZ-101 and an organic sand at PZ-102. At PZ-103, materials beneath the fill were not penetrated.

The fill encountered at the MW-201, MW-202, and MW-203 clusters consisted of a fine sand, with a trace amount of cobbles at the MW-201 cluster. Cinders were encountered in the fill at the MW-202 cluster. Beneath the fill, 2.5- to 3-foot-thick deposits of peat were encountered at the OW 41/43 cluster and at the MW-202 and MW-203 clusters. Beneath the peat at the MW-202 and MW-203 clusters, approximately 32 feet of outwash was encountered underlain by 6.5 feet of basal till at MW-203 and 31 feet of basal till at the MW-202 cluster. Beneath the fill at the MW-201 cluster, 10-feet of ablation till was encountered and is underlain by 43.5 feet of basal till. Granite bedrock, interpreted to be the Andover Granite, was encountered beneath the overburden at all three wells. At the MW-202 cluster, a 3-foot-thick zone of weathered bedrock was present above the competent bedrock.

At the background well cluster (MW-200), no fill was encountered. Beneath a thin layer of topsoil, approximately 1 foot of outwash is underlain by 13 feet of ablation till and 9.5 feet of basal till. Bedrock, encountered at a depth of 25 feet, was interpreted to be either the Sharpner's Pond or Straw Hollow Diorite. At MW-200, a 15-foot-thick zone of weathered diorite was present above the more competent diorite bedrock.

Geotechnical samples were collected during soil sampling and the installation of the MW-series monitoring wells. One soil sample from a boring drilled in natural materials in this area consisted predominantly of sand with lesser fractions of gravel and silt/clay. The organic content of the sample was 0.44%, the average porosity was 45%, and the vertical hydraulic conductivity was 3.6×10^{-3} cm/sec. A sample submitted from the fill material encountered in this area consisted of sand and gravel with a minor amount of silt/clay, an organic content of 1.6%, an average porosity of 42%, and a vertical hydraulic conductivity of 1.8×10^{-3} cm/sec. Grain-size distributions for the Old B&M Oil/sludge Recycling Area were calculated on geotechnical samples collected during the installation of monitoring wells. Average grain size distributions for the basal till consisted of 30% clay, 26.5% silt, 30% sand and 13.5% gravel. Grain sizes of ablation till consist of 3% clay, 23% silt, 63% sand, and 11% gravel. Grain sizes for the outwash consist of 95.5% sand, and 2% gravel.

> **Old B&M Oil/Sludge Recycling Area Summary of Conditions.** Geologic conditions are summarized in cross-section F-F' (Figure 3-17). Descriptions of fill materials from soil boring and test pit logs mention black sand, black ash, layers of oily silt, and clay, oil-stained soils, free product, black slag, black sand with oily odor, bricks, wood, glass, and foam. Beneath the landfill materials are sequences of glacial outwash and glacial till, with the till occurring in the southern portion of the area.
>
> Two different bedrock lithologies were encountered in the vicinity of the Old B&M Oil/Sludge Recycling area. At the MW-200 cluster, diorite was encountered, and at the MW-201 cluster, the Andover Granite was encountered. Bedrock elevations along the F-F' (Figure 3-17) cross-sectional line ranged from 64 to 106 feet NGVD.

Asbestos Lagoons. The Asbestos Lagoons are a pair of bermed lagoons bordered on the south, east, and west by the Iron Horse Industrial Park complex, on the northwest by the Middlesex Canal, and on the north by a sparsely vegetated open area. The subsurface of the Asbestos Lagoons area was not investigated using geophysical surveys, soil borings, or test pit investigations. Subsurface data were collected as part of the installation of PZ-series piezometers and MW-series monitoring wells. Geologic conditions occurring in the vicinity of the Asbestos Lagoons are summarized in cross-section G-G' (Figure 3-18) and H-H' (Figure 3-19).

One well cluster (MW-208) and one bedrock well (MW-209B) were installed to further investigate and characterize groundwater conditions in the vicinity of the Asbestos Lagoons. The MW-208 cluster was installed as an upgradient monitoring location for the Asbestos Lagoons. Bedrock well MW-209B was installed to complete the OW-20/21 cluster, which is downgradient of the lagoons.

Four feet of fill was encountered at the MW-208 cluster, consisting of sand, cinders, and cobbles or boulders. Beneath the fill, a 3-foot layer of organic silt was encountered, underlain by 34 feet of outwash and 16.5 feet of ablation till. Granite bedrock, interpreted to be the Andover Granite, was encountered at the MW-208 cluster. A 2.5-foot thick zone of weathered bedrock was encountered above the competent bedrock. No split-spoon samples were collected at MW-209B; however, drill cuttings suggested that the overburden consists primarily of glacial outwash. Bedrock was encountered at MW-209B at 37 feet below the ground surface and was interpreted to be schist of the Nashoba formation. Above the competent bedrock, a 4-foot-thick zone of weathered bedrock was encountered.

A grain-size analysis was performed on samples collected during the installation of the monitoring wells at the Asbestos Lagoons. Average grain-size distributions for outwash were 2% clay, 11% silt, 73 to 95% sand, 0.3 to 18% gravel.

> **Asbestos Lagoons Summary of Geologic Conditions.** The Asbestos Lagoons area can be characterized by artificial fill materials in the vicinity of the MW-208 cluster and PZ-107, consisting primarily of reworked sand and gravel, with some cinders. The fill is underlain by peat, glacial outwash, and ablation till. Bedrock in the vicinity of the lagoons has been logged as granite, interpreted to be the Andover Granite at the MW-208 cluster, and schist, interpreted to be the Nashoba Formation, occurs at MW-209B.

3.3 HYDROGEOLOGY

This section discusses the occurrence of regional and site-related groundwater, which was investigated in each of the five areas of concern.

3.3.1 Regional Hydrogeology

The regional hydrogeology was assessed using available literature including previous investigations of the Site, which are referenced in section 1.0.

3.3.1.1 Regional Surface Water. The Site is located near the western edge of the Shawsheen-Merrimack River drainage basin. The boundary between the Concord River basin (west) and the Shawsheen River drainage basin (east) is west of the Site, coincident with High Street. The Shawsheen River, which flows north, is located approximately 3 miles east of the Site. The Shawsheen River drains a 77-square-mile area of eastern Massachusetts and discharges into the Merrimack River approximately 10 miles north of the Site. Principal tributaries of the Shawsheen River include Content, Elm, Heath, Hussey, Kiln, Rogers, Spring, Strong Water, Vine, and Webb Brooks. Other drainage basins in the area include the Concord River drainage basin west of the Site, the Mystic and Ipswich River drainage basins to the east, and the Charles River drainage basin to the south (Gay and Delaney, 1981).

The physiography of the Shawsheen River drainage basin is characterized by small hills separated by, in some cases, expansive wetlands areas with relatively low topographic relief. The lowest elevation on the Shawsheen River is 10 feet NGVD at its confluence with the Merrimack, with the highest point approximately 200 to 300 feet NGVD in the hills surrounding the source. According to Gay and Delaney (1980), the Shawsheen River has an average gradient of approximately 3.8 feet/mile, or 0.00072 feet/feet. The combination of low relief and poor drainage has resulted in the occurrence of many wetlands throughout the Shawsheen River basin (Gay and Delaney, 1980).

In 1974, discharge was recorded at the Shawsheen Avenue (Massachusetts state route 129) gauging station, (Wilmington, Massachusetts) during medium flow, at a rate of approximately 45 cubic feet/second. The average annual precipitation in the Shawsheen drainage basin is 40.7 inches with an average annual runoff of 20.2 inches. Generally, highest run-off occurs in March (3 to 4 inches/month) and the lowest runoff between August and October (less than 1 inch/month) (Gay and Delaney, 1980).

3.3.1.2 Regional Groundwater. Groundwater occurs within the glacial deposits and in the bedrock of the Shawsheen River drainage basin.

Groundwater in the overburden occurs mostly in the more permeable glacial drift deposits (ice-contact and outwash deposits) but is also found in glacial till deposits. The most favorable areas for groundwater production and development are those underlain by stratified drift (outwash) deposits. In the Shawsheen River drainage basin, transmissivities having a minimum value of 10 feet^2/day, in the unstratified glacial till deposits are found primarily in the headwaters of the Shawsheen River south of the Site. Maximum transmissivities are reported to be on the order of 10,000 feet^2/day in the stratified drift deposits of sand and gravel found in the vicinity of the Site (Gay and Delaney, 1980).

Groundwater recharge occurs primarily during the late winter and early spring (February and March) when surface runoff is the highest and evapotranspiration is the lowest. More extensive vegetative cover between the months of May and September results in lower groundwater recharge rates and decreased groundwater storage, which combine to reduce the base flow to surface water streams (Gay and Delaney, 1980).

Groundwater in the bedrock is found in joints and fractures, which are usually small and persist for only short distances. Transmissivities in the bedrock vary greatly depending upon the occurrence and interconnection of joints and fractures. Groundwater storativity in bedrock underlying the Shawsheen River drainage basin is generally low. In locations where the fractures are smaller and poorly connected, well yields are approximately 10 gallons per minute (gpm) or less. In locations where the fractures are large and well connected, well yields may be as high as 100 gpm. Sufficient quantities of water to supply single-family homes are available from the bedrock aquifer throughout the Shawsheen River drainage basin (Gay and Delaney, 1980).

3.3.2 Site Hydrogeology

The hydrogeologic conditions of the Site were assessed using existing and new monitoring wells and piezometers, surface water elevation gauges, and seepage meters (Figure 2-5).

As part of the preliminary hydrogeologic assessment to develop a field program for evaluating groundwater contamination, an inventory of the existing OW-series monitoring wells and P-series piezometers was completed (section 2.1.1.4). The findings of the initial groundwater monitoring investigation (section 2.1.1.4) were used to place 18 piezometers (PZ-series) for an initial characterization of site-specific shallow groundwater flow. The piezometers were installed in groups of three at the five areas of concern on the Site (section 2.1.5).

Based on water level elevations measured in the new piezometers as well as in the OW-series monitoring wells and piezometers, 15 new monitoring well cluster locations (MW-200 series) were sited to further assess hydrogeologic conditions and water quality at the five separate areas of concern, as well as upgradient of the Site (section 2.1.6). Each cluster consists of a shallow and deep overburden and bedrock well (with the exception of the MW-210 cluster, which has a shallow overburden and a bedrock well only). The shallow and deep overburden wells were installed with a 10-foot screened interval. In addition, two new bedrock wells (MW-207B and MW-209B) were installed to complete existing OW-series clusters (CDM, 1987). The MW-207B well was installed at OW-25/26/27 cluster and the MW-209B well was installed at the OW-20/21 cluster. A background well cluster (MW-200) was sited upgradient (north) of the Site. In addition, a total of 14 staff gauges and 9 seepage meters were also installed (section 2.1.1.4) to monitor surface water elevations and determine the relationship between groundwater and surface water on the Site. The locations of the monitoring wells, piezometers, staff gauges, and the seepage meters are shown in Figure 3-10. Monitoring well specifications and well development data are provided in Table 3-2. Stratigraphic data obtained from the installation of monitoring wells is provided in Table 3-2.

3.3.2.1 Site Surface Water. The Site is located within the Content Brook watershed, which is part of the Shawsheen River drainage basin. The Site is on the western edge of the Shawsheen River drainage basin; a drainage divide occurs near High Street, west of which drainage is to the Concord River. The Middlesex Canal, which crosses the Site from west to east, is the main conveyance for surface water at the Site and drains to the northeast through the main wetland areas of the Site. A smaller stream, which is known as the unnamed brook, crosses the Site from south to north along the eastern edge of the Iron Horse Industrial Park. A second smaller stream also crosses the Site from south to north on the western side of the Site. Other surface water bodies include the B&M Pond located just east of the B&M Railroad Landfill, and a ponded area of the unnamed brook west of the B&M Lagoons. Site drainage is to the north and east towards Content Brook, which is just east of Shaffer Landfill.

Based on information obtained from a planning map recorded with the Middlesex Registry of Deeds (Lowell, Massachusetts) in 1911, a small stream, Cold Brook, originally flowed across the center of the Site, even after construction of the Middlesex Canal. According to the map, Cold Brook originated near or within what is now the Old B&M Oil/Sludge Recycling Area and flowed northeast and then east through what is now the B&M Landfill. Besides the Middlesex Canal, constructed earlier, Cold Brook was apparently the major surface water conveyance on the Site. The subsequent construction of the B&M Railroad spur and B&M Railroad Landfill evidently prompted the filling of Cold Brook and its associated wetlands and the construction of alternate surface water drainage pathways such as the unnamed brook. For this reason, the unnamed brook and the other north-flowing brook on the west side of the Site have modified or man-made channels along much of their reaches.

The Middlesex Canal is a manmade waterway completed in 1803 to facilitate the transportation of goods between Boston and Lowell. Where possible, the canal was routed to intercept low-lying wetlands and existing surface water bodies. In some areas, the canal was constructed with a bottom consisting of compacted clay.

The Middlesex Canal enters the Site on the west side along High Street. A former barge turnout north of the canal is located to the northwest of the Asbestos Lagoons. According to GZA (1987), local topographic maps, and hydrologic maps (Gay and Delaney 1980 and 1981), flow in the Middlesex Canal at the Site near High Street is to the west, toward the Concord River, suggesting the existence of a regional surface water divide. East of the inferred divide, the canal is thought to flow east along the northern perimeter of the Site until it is directed under the railroad spur through a culvert. Water flowing through the culvert emerges at an outfall just north of the B&M Railroad Landfill, where it then flows into B&M Pond, acting as a conveyance of drainage for the B&M Pond and the wetlands south of the pond. The Middlesex Canal joins Content Brook east of the Site approximately 250 feet east of the southeast end of Shaffer Landfill.

Based on a historical map of the canal (MCA, 1967) and previous groundwater elevation data (M&E, 1994a), the Middlesex Canal formerly flowed eastward across the Site before it was rerouted to the north to construct the railroad spur. Thus, the central portion of the Site under the railroad spur contains a portion of the canal that was filled in. As mentioned above, the canal now flows along the northern perimeter of the Site and is directed under the railroad spur and into the B&M Pond through a culvert. The now-filled portion of the canal was formerly connected to the segment which is south of the B&M Landfill and is connected to the B&M Pond.

The unnamed brook, which contributes to the drainage of the southern and eastern portions of the Site, originates south of the Site, just east of the Purity Supreme warehouse and flows west and then northeast across the Site. Southeast of the B&M Locomotive Shop Disposal Areas, the unnamed brook is intersected by a canal that was observed to extend from the Area A and Area B, to the southeast towards Pond Street. Although it was not measured, based on the topography, flow in this canal is most likely west toward the unnamed brook. The unnamed brook flows into the B&M Pond at a point northeast of the RSI Landfill through a large wetland northeast of the RSI and Asbestos Landfills.

Richardson Pond, located north of Shaffer Landfill, is drained by Content Brook. Richardson Pond is surrounded by a large wetland area which divides the pond into two sections (M&E, 1995).

Site Surface Water Elevations. Site surface water elevations were monitoring at 14 staff gauge locations in the Middlesex Canal, the unnamed brook, and the small stream on the west side of the Site. Surface water elevations were monitored during groundwater elevation monitoring rounds. Surface water levels were observed to fluctuate by approximately 0.5 to 1.0 feet between the April 1995 and August 1995 rounds, with levels being lower in August. Surface water elevations are presented in Table 3-4. Site surface water elevation data is presented in Appendix E.

Streambed Conductivities. The streambed conductivity, or the vertical hydraulic conductivity (Kv) of the streambed, was estimated at nine locations where seepage meters had been installed in surface water bodies on the Site. The quantity of water induced to flow through a streambed is a function of the vertical hydraulic conductivity of the streambed material, the area through which induced infiltration occurs, and the hydraulic gradient across the streambed. The Kv, in feet/day, was calculated using Darcy's equation:

$$Kv = Q/Ai$$

where $i = (h_1 - h_2)/L$

and where:

Q	is the flow into or out of the stream reach
A	is the area of the streambed
i	is the hydraulic gradient
h_1	is the altitude of the head in the stream
h_2	is the altitude of the head in the aquifer beneath the streambed
L	is the streambed thickness

Streambed conductivities determined at the nine locations are provided in Table 3-5. Vertical hydraulic conductivities ranged from 0.2 to 41 feet/day. Values of Kv measured in the eastern segment of the Middlesex Canal near the B&M Railroad Landfill (SM-1 and SM-2) were higher than other values on Site. The Middlesex Canal is reportedly clay-lined, but not continuously. Because the canal may be an extension of the B&M Pond near SM-1 and SM-2, a liner may not have been necessary.

Values of Kv measured in the unnamed stream, east of the RSI Landfill, showed an order of magnitude variation (4 to 41 feet/day). SM-3 (41 feet/day) is upgradient of the culvert at the northeast corner of the landfill. Sediments were observed to have built up at this location below the bottom of the culvert; therefore, it is possible that the streambed comprises coarser-grained materials at this location.

Streambed conductivities, measured at SM-5 and SM-6 in the northern segment of the Middlesex Canal, west of the Asbestos Lagoons, ranged from 1.0 to 3.0 feet/day. Values measured in the unnamed stream between Locomotive Shop Disposal Areas A and B (SM-7 and SM-8) were consistent (0.16 to 0.32 feet/day) and the lower values are consistent with high proportions of silt observed in the unnamed stream bed at these locations.

The single vertical hydraulic conductivity value measured in Richardson Pond (0.22 feet/day) was also in an area where a significant thickness of silty organic material was present.

The vertical hydraulic conductivity values measured provide a quantitative estimate of how well site groundwater is connected to surface water which in some areas may be affected by the presence of a clay liner in the Middlesex Canal or other fine-grained sediments in the streambed. Values of streambed hydraulic conductivity from other studies in the northeast reportedly range from approximately two to ten feet/day (de Lima, 1991). The degree to which the Site has been altered (canal, landfilling, etc.) may account for values that do not fall into the published range reported above.

The relationship of site groundwater to surface water is discussed in the following section.

3.3.2.2 Site Groundwater. Groundwater at the Site exists under water table conditions in an overburden aquifer that is composed of glacial drift materials. Because of a saturated thickness averaging approximately 40 feet, the overburden aquifer was subdivided into a shallow and a deep overburden aquifer to gain definition on the overburden groundwater flow regime and to aid in determining the potential for contaminated groundwater transport by vertical migration pathways. Groundwater is also present within the crystalline bedrock underlying the Site. Groundwater is contained and transmitted in the weathered bedrock zone, where present, or in secondary interstices such as joints and fractures in the more competent rock.

Groundwater elevations at the Site are presented in Table 3-4 and groundwater elevation data for the Site are presented in Appendix E.

Overburden Groundwater. Groundwater in the overburden aquifer occurs at average site-wide depths of approximately 1.0 to 9.0 feet below the ground surface. Shallow and deep overburden monitoring wells were screened predominantly in glacial outwash deposits; however, in some locations, due to local stratigraphy, screens were installed in other units or partially in other units including ablation till, basal till, and silty peat. Table 3-2 provides the materials screened at each monitoring well location.

Hydraulic Conductivities. Slug testing results for the wells screened in the outwash, ablation till, basal till, and peat are presented in Table 3-6. The hydraulic conductivity values reported for each monitoring well location in Table 3-6 is the average of the rising and falling head slug tests. A geometric mean was used when determining the average value of horizontal hydraulic conductivity (Kh) for each stratigraphic unit since an arithmetic mean of a given data set tends to give more weight to the more permeable values (Fetter, 1994). Mean Kh values were compared with hydraulic conductivity data from the OW-series monitoring wells and to published values for the types of materials screened. Aquifer testing data is included in Appendix E.

The mean (site-wide) Kh estimated for the outwash (27 feet/day) is assumed to be low because the Kh values in monitoring wells MW-206S, MW-208S, MW-208D, and MW-212D were not included in the outwash data set. Values of Kh at these wells could not be calculated because water levels in these wells recovered so rapidly during testing that a linear regression could not be performed on the aquifer response data curves. As a result, the values at these four wells are assumed to be greater than at other well locations screened in glacial outwash. This may explain why the mean Kh is low when compared to that for the OW-series wells screened in outwash (43.3 feet/day).

Glacial outwash in the shallow overburden is apparently more permeable than that in the deep overburden as evidenced by geometric mean values of 59 feet/day and 31 feet/day respectively for the MW-series monitoring wells and 40 feet/day and 18 feet/day respectively for the OW-series wells.

Ranges of published hydraulic conductivity values were 3 to 280 feet/day for glacial outwash deposits (Fetter, 1994) and 0.25 to 142 feet/day for medium sand (Domenico and Swartz, 1990). Values obtained for the Site are near the lower end of these ranges, possibly attributable to the presence of silt which was described in some samples. The average proportion of silt reported for outwash samples in this area submitted for geotechnical analyses was approximately 20%.

Hydraulic conductivity values reported for MW-series monitoring wells screened only in ablation till or basal till yielded geometric means of 9.8 feet/day and 2.4×10^{-1} respectively. The values reported for basal till fall on the high end of the range expected for till (10^{-7} to

10^{-1} feet/day; Freeze and Cherry, 1979); however, values reported for wells screened in the ablation till are just outside this range, indicating that ablation till on the Site may have higher quantities of sand or gravel than is typical for glacial till. None of the OW-series wells are screened in till.

The MW-series monitoring wells that were screened across peat and outwash yielded a geometric mean of 6.6 feet/day, while the geometric mean of OW-series wells screened in these materials was 5.8 feet/day.

Seepage velocities in the overburden were calculated based on hydraulic conductivities, horizontal hydraulic gradients, and porosity. Porosity values were measured on geotechnical samples obtained during the installation of the new monitoring wells. Seepage velocity calculations were performed using the April 1995 and August 1995 water level measurements and are summarized in Tables 3-7. During the April 1995 water level elevation round, calculated seepage velocities for the shallow overburden ranged from a maximum of 0.2040 feet/day on the southwestern side of the Site to 0.0217 feet/day on the northeastern side of the Site. During the August 1995 water level elevation round, calculated shallow overburden seepage velocities ranged from maximum values of 0.1261 on the southwestern side of the Site to a minimum of 0.0178 on the northeastern side of the Site. These results demonstrate a range of two orders of magnitude between seepage velocities in the southwest corner near the MW-200 cluster and the rest of the Site. These data are interpreted to reflect the high horizontal hydraulic gradients in the southwestern side of the Site.

Bedrock Groundwater. Groundwater is present in the fractured crystalline bedrock underlying the Site. Groundwater is contained and transmitted in the weathered bedrock or in secondary interstices such as joints and fractures which impart a secondary porosity to the more competent bedrock. The porosity of weathered igneous rocks may range from 30 to 60% (Fetter, 1994), while the porosity of fractured igneous rocks generally ranges from 0 to 10% (Freeze and Cherry, 1979). Bedrock monitoring wells at the Site were installed at a maximum depth of 30 feet into competent bedrock, with 20 feet screened in the zone containing the most fractures as determined from the condition of cuttings and drilling times. The MW-series bedrock monitoring wells were screened at depths of 23 to 100 feet below the ground surface.

The bedrock monitoring wells were screened predominantly in granite, with only several wells being screened in diorite or schist. Differences in lithology did not appear to cause trends in estimated hydraulic conductivity values when compared among bedrock monitoring wells across the Site.

Hydraulic Conductivities. The range of Kh values measured for the MW-series bedrock monitoring wells is 9.5×10^{-2} to 21.0 feet/day (Table 3-6). The geometric mean of hydraulic conductivities calculated from data collected in MW-series bedrock monitoring wells is 0.42 feet/day while that of the OW-series wells is 0.38 feet/day. Ranges of published values expected for fractured crystalline rocks include 0.0023 to 85.0 feet/day (Domenico and Schwartz, 1990) and 0.071 to 28.0 feet/day. These values indicate that those reported for the Site are approximately at the midpoint of the range expected for fractured igneous and metamorphic rocks.

The highest Kh value measured in a bedrock well, 21 feet/day at MW-212B, is near the higher end of published values. Drilling conditions at this location indicated that the granite bedrock surface is highly fractured, as suggested by water loss in the borehole during drilling. Due to the loss of drilling water circulation, the borehole could not be advanced to the proposed maximum depth of 30 feet into bedrock without using large volumes of water. The well was installed with the screened interval intersecting the upper highly fractured zone which would account for the higher Kh value.

The distribution of bedrock hydraulic conductivity values across the Site (OW- and MW-series monitoring wells) indicates that to some extent lower Kh values are associated with bedrock at lower elevations and higher Kh values tend to correspond with wells located on bedrock highs.

Groundwater Movement. Based on interpretations of contours drawn from groundwater elevation data measured in April and August 1995 (Figures 3-20 through 3-25) groundwater in both the bedrock and overburden generally enters the Site from the southwest and flows to the northeast. Consistently over the two periods of measurement, the highest groundwater elevations on the Site occurred at MW-200S (shallow overburden) in the southwestern corner of the Site, and the lowest groundwater elevation occurred at OW-51 (shallow overburden) in the northeastern corner of the Site. Site-wide, groundwater elevations were on the order of 0.5 feet lower in August 1995 than in April 1995. A localized groundwater divide near the center of the Site causes flow to the north in both the overburden and bedrock, most likely influenced by the more western portion of the Middlesex Canal and possibly the buried portion of the canal, since evidence for the divide is absent north of that point. The divide may also be the result of an isolated bedrock high.

An apparent change in the horizontal hydraulic gradient is reflected in groundwater elevation contours for the shallow and deep overburden and bedrock during both measurement periods. This difference in the hydraulic gradient, is evidenced by gradients being steeper at the southwest corner of the Site such as B&M Locomotive Shop Area A and the Old B&M Oil/Sludge Recycling Area. As a confirmation of the steepening of the hydraulic gradient at the southern end of the Site, surveyed elevations of groundwater measuring points at the southwest end of the Site were verified. It is expected that in the overburden, this change in the hydraulic gradient is related to the thickness of basal till which comprises most of the overburden thickness at this location. As verified by hydraulic conductivity testing, the basal till has a lower Kh value and would thus tend to effect an increase in the hydraulic gradient.

Site-wide, the water table occurs at depths of approximately 1.0 to 9.0 feet below the ground surface. Fluctuations in the direction of flow of shallow overburden groundwater near the Asbestos Lagoon and in the vicinity of the previously mentioned groundwater divide may be the result of manmade changes including the creation and relocation of the Middlesex Canal as well as the construction of the Asbestos Lagoons. In April 1995, apparent mounding in the water table near the Asbestos Lagoon as well as localized bimodal flow directions (northwest and northeast) were observed (Figure 3-22). These features may be caused by berming of low-permeability materials in the lagoons as well as the filled portion of the Middlesex Canal that most likely underlies the area just north of the Asbestos Lagoons. This feature is somewhat less pronounced in the August 1995 groundwater contours (Figure 3-24) presumably because of lower groundwater elevations.

Elsewhere on the Site, mounding was observed in shallow overburden groundwater in the vicinity of piezometer P-10, which is coincident with thinning overburden and a bedrock high associated with a ridge of granite in the southeast corner of the Site.

Groundwater elevation contour maps generated for the deep overburden illustrate flow directions similar to the shallow overburden, with the exception of localized flow to the east in the center of the Site coincident with the location and general trend of the trough in the bedrock surface. The bedrock trough may influence deep overburden groundwater flow at this location. This feature is less pronounced in groundwater contours drawn from the August 1995 data, possibly because of a lower groundwater flux thus reducing the hydraulic gradient.

The localized groundwater divide is present and more pronounced in the deep overburden, the configuration of the groundwater contours suggest that it may be related to the isolated bedrock high in the center of the Site.

Groundwater flow directions in the bedrock are similar to those in the deep overburden. The localized groundwater divide is apparent in the bedrock groundwater contours and, as mentioned above, may be related to an isolated bedrock high. The contouring suggests that there is preferential flow in the bedrock near the center of Site, which is influenced by the presence of the trough in the bedrock surface.

Horizontal Hydraulic Gradients. Horizontal hydraulic gradients for both the overburden and bedrock were calculated using both rounds of water level data and are presented in Table 3-8. Horizontal hydraulic gradients at the Site range from 9.6×10^{-4} feet/feet in the B&M Railroad Landfill to 1.7×10^{-2} feet/feet at the background well cluster (MW-200). Horizontal hydraulic gradients are further discussed in section 3.3.2.3.

The majority of the Site has overburden and bedrock hydraulic gradients on the order of 0.001 to 0.003, with the exception of the southwestern corner, which has gradients on the order of 0.01 feet/feet. Higher horizontal hydraulic gradients were observed in the southwestern end of the Site where the basal till occurs. As mentioned previously, the basal till may act as a confining layer, thereby increasing hydraulic potential where it is present. Lower horizontal hydraulic gradients occur in the northern end of the Site, specifically in the B&M Railroad Landfill, where gradients in the overburden and bedrock range from 0.0009 to 0.001 feet/feet.

Vertical Hydraulic Gradients. Water level elevation data collected during the April and August 1995 rounds were used to calculate vertical gradients in groundwater at the Site. Groundwater elevations measured in monitoring well clusters across the Site generally indicate only slight potential differences in head between the shallow overburden and deep overburden and between the deep overburden and bedrock, suggesting that the aquifers are well connected. At monitoring well clusters, vertical hydraulic gradients measured between shallow and deep overburden as well as deep overburden and bedrock indicate that vertical gradients across the Site are on the order of 0.01 to 0.001 feet/feet. Table 3-9 summarizes the directions of vertical gradients.

During the April 1995 groundwater elevation round, vertical gradients ranged from 0 to 0.034 feet/feet and, during the August 1995 round, gradients ranged from 0 to 0.04 feet/feet. The number of negative (downward flowing) gradients was slightly greater than the number of positive (upward flowing) gradients, indicating groundwater recharge. Measured vertical gradients calculated for 1995 were consistent with data collected in 1994.

Surface Water. Surface water elevations measured during groundwater elevation rounds in April and August 1995 are shown in Figures 3-26 and 3-27. Several apparently anomalous water elevations recorded consistently are shown and noted on the figures but are disregarded in the discussion. These locations have most likely been affected by ice, since the apparent anomalous readings are associated with staff gauges installed in 1993.

Based on measurements of surface water elevations using staff gauges and seepage meters, surface water elevations are highest in wetlands west of the Old B&M Oil/Sludge Recycling Area (SG-12) and lowest in the B&M Pond (SG-5) and Richardson Pond (SG-11) in the northeast corner of the Site. As with groundwater, surface water flows onto the Site from the south and flows across the Site to the northeast, where it converges in the B&M Pond and associated wetlands.

Surface water enters the Site from the south as two small streams separated by a topographic high coincident with the railroad spur south of the Site. On the west side, one of the streams connecting several ponds and wetlands flows into the Middlesex Canal. To the east, the unnamed brook flows from the Locomotive Shop Disposal Areas past the RSI Landfill and discharges to wetlands at the northeast corner of the Site.

As determined from staff gauge and seepage water measurements, flow in the Middlesex Canal is from west to east across the Site with low discharge. No evidence was found to suggest a surface water divide in the canal on the Site. It is suspected that a divide may occur in the canal west of the Site, coincident with the drainage divide between the Shawsheen and Concord River basins.

Groundwater-Surface Water Interaction. A comparison of groundwater and surface water elevations, measured at the 9 seepage meter locations installed during this investigation, indicates the potential for shallow groundwater to discharge to surface water at all locations except one (SM-3) where no gradient was observed. (The actual discharge that is occurring depends on the hydraulic conductivity of the streambed at a given location). This type of interaction is also suggested by site-wide staff gauge measurements and water levels at a shallow overburden well also measured nearby. The one exception was at SG-1 (near Spincraft), where surface water and shallow groundwater (OW-33) measurements have consistently suggested that the stream is recharging groundwater at that location. Shallow groundwater contours for April and August 1995 also suggest mounding in that location, which may indicate that this area was filled with a less-permeable material than in other areas of the Site.

Mini-piezometers previously installed in surface water bodies across the Site (CDM, 1989b) also indicated discharge by shallow groundwater into the Middlesex Canal, the unnamed brook, and the B&M Pond. Groundwater and surface water interactions are discussed in more detail for each area of concern in the following section.

Groundwater flow conditions in the overburden and bedrock and groundwater-surface water interactions at each area of concern are also discussed in the following section.

3.3.2.3 Area-Specific Hydrogeology. Groundwater conditions and groundwater-surface water interactions are discussed in this section.

B&M Railroad Landfill. Groundwater flow directions in the B&M Railroad Landfill in April and August 1995 (Figures 3-20 through 3-25) were observed to be generally to the east-northeast in the shallow and deep overburden and bedrock with some radial flow occurring at the north and south edges of the landfill. Although disposal activities in the landfill may locally alter groundwater flow patterns, these effects were not apparent from groundwater contours drawn even at a 0.5 foot contour interval.

Hydraulic conductivities (Kh) for the landfill were calculated for glacial outwash and bedrock (Table 3-6). Values reported for outwash were 4.4 and 10.0 feet/day. Site-wide, Kh values for outwash were higher than those encountered at the landfill suggesting that outwash there may have higher proportions of silt, however, geotechnical analysis of three outwash samples from the landfill indicate higher proportions of sand and gravel with negligible amounts of silt. Values of Kh for bedrock at the landfill ranged from 0.06 to 0.36 feet/day and in general are lower than the geometric mean of the Site for bedrock, which suggests that the bedrock may be less fractured here than at other locations.

Horizontal hydraulic gradients calculated at the B&M Railroad Landfill are the lowest on the Site and represent a decrease from hydraulic gradients in the central portion of the Site. Similar values were noted in the overburden and bedrock as determined from each water level round with slightly lower values noted in the August 95 data (Table 3-8). These lower horizontal hydraulic gradient values may be attributed to a greater saturated thickness of the overburden at this location due to deepening of the bedrock surface.

Vertical gradients for the landfill at the MW-213, MW-214, and MW-215 clusters indicate that some groundwater flows upward from the bedrock to the shallow overburden, most notably at the MW-213 cluster where the potential for upward flow is the greatest. At the MW-214 and MW-215 clusters, weaker vertical gradients are present but still suggest the potential for upward flow.

Groundwater elevations are higher than surface water elevations measured in the Middlesex Canal or the B&M Pond, indicating that groundwater discharge to surface water is likely from both the overburden and bedrock. This discharge was quantified in the two seepage meters installed in the Middlesex Canal.

Groundwater elevation contours indicate that the OW-34/35/36 cluster is hydrogeologically upgradient of the landfill. The cluster was originally proposed to represent background groundwater conditions for the landfill.

Seepage velocities at the landfill are the lowest on the Site and range from approximately 0.003 feet/day in the bedrock to approximately 0.02 feet/day in the overburden (Table 3-7). Velocities did not vary greatly between April and August 1995, with values within the same order of magnitude. Highest velocities were reported for the landfill in the shallow overburden in April 1995 (Table 3-7).

> **B&M Railroad Landfill Summary of Conditions.** Overburden and bedrock groundwater flow at the B&M Railroad Landfill is to the east-northeast with some radial flow along the northern and southern edges, influenced by the B&M Pond and the Middlesex Canal. Upward vertical gradients from bedrock to shallow overburden were determined to occur at monitoring well clusters along the eastern edge of the landfill. Groundwater discharge from overburden and bedrock to the B&M Pond and the Middlesex Canal is suggested by a comparison of groundwater and surface water elevations.

RSI Landfill. Groundwater flow directions within the overburden and bedrock underlying the RSI Landfill are to the northeast. Based on comparison with surface water elevations, it is expected that both shallow and deep overburden as well as bedrock groundwater is influenced locally by the unnamed brook on the south side of the landfill. Groundwater flow at the landfill is also likely influenced by the large wetland area to the northeast. Groundwater elevations measured in the shallow and deep overburden and bedrock in MW-series monitoring well clusters installed in the vicinity of the landfill are very similar, indicating a possible connection between the three units. This is most evident at the MW-212 cluster, where groundwater elevations for all three units are nearly identical in both rounds and the hydraulic conductivities of the overburden and bedrock are elevated with respect to other locations.

Bedrock groundwater elevation contours (Figures 3-20 and 3-23) indicate that bedrock monitoring well MW-207B is hydrogeologically upgradient of the landfill. As previously discussed, MW-207B was installed to complete the OW-25/26/27 cluster and establish groundwater quality upgradient of the landfill.

Hydraulic conductivities for the RSI Landfill were calculated for glacial outwash and ablation till (Table 3-6). Values for outwash ranged from 34.0 feet/day at MW-211D to 100.0 feet/day at MW-212S, with an average value of 67 feet/day. Values for ablation till were 7.1 feet/day at MW-210S. Site-wide, the values for outwash were lower than those encountered at the landfill, with the site-wide geometric mean for the outwash of 27.0 feet/day. Values of Kh for bedrock at the landfill ranged from 0.045 to 21 feet/day. Bedrock may be more highly fractured at the MW-212 cluster, where a Kh value of 21 feet/day was calculated.

Horizontal hydraulic gradients within the landfill vary only slightly between lithologies from approximately 0.002 feet/feet in bedrock to 0.0025 feet/feet in the shallow overburden (Table 3-8). Variation in gradients between April 1995 and August 1995 are small, varying by only 0.0005 feet/feet. Seepage velocities within the landfill vary from approximately 0.25 feet/day in the overburden to 0.02 feet/day in bedrock.

Vertical gradients, calculated using groundwater elevations from monitoring well clusters near the RSI Landfill, are very low and suggest that the vertical component of groundwater flow is minimal at this location. At the MW-210 cluster, where bedrock is close to the surface, a slight upward vertical gradient was calculated from the April 1995 data and a slight downward gradient was determined from the August 1995 data. At the MW-211 cluster, a slight upward gradient was observed during both rounds, while at the MW-212 cluster, practically no vertical movement of groundwater is reflected in the data.

Comparisons of groundwater and surface water elevations measured at seepage meters SM-3 and SM-4 in the unnamed stream indicate that, at the MW-210 cluster, groundwater in both the overburden and bedrock potentially discharges to the unnamed stream, according to both rounds of data. Measurements made at SM-4 suggest that groundwater is discharging to surface water at that location, which is adjacent to the MW-210 cluster.

At the MW-212 cluster, groundwater elevations in the overburden and bedrock are lower than surface water elevations measured nearby in the unnamed stream at SM-3, indicating the potential for the stream to lose water to groundwater at this location. This is most likely because the unnamed stream has an earthen dam with a culvert across it, just downstream from SM-3. The elevation of the culvert is too high to allow the stream to flow through it at the rate at which it approaches the culvert. The stream is backed up, and as a result, recharges groundwater at this location. Groundwater-surface water relations measured at the streambed piezometer at SM-3 demonstrated a neutral vertical gradient in April 1995 and slight downward gradient (from surface water recharging groundwater) in August 1995.

Vertical hydraulic gradients were determined from April and August 1995 water level elevations at the MW-210, MW-211 and MW-212, OW-01/02/03, and OW-07/08 clusters. Neutral gradients were measured consistently between all units at the MW-212 and OW-07/08 clusters. At the MW-210 cluster, variable hydraulic gradients were measured between the two rounds. At the OW-01/02/03 cluster, an upward gradient between all units was consistently measured. At the MW-211 cluster, an upward gradient between the bedrock and deep overburden was consistently measured while a neutral gradient between deep overburden and the shallow overburden was observed.

The relationship between surface water and groundwater at the RSI Landfill was assessed using vertical gradient and streambed conductivity data from MW-210 and SM-4 and from MW-212 and SM-3. According to water level data, two of the three shallow overburden wells (MW-210S and OW-03) in the vicinity of the unnamed brook had higher hydraulic heads than the surface water suggesting shallow groundwater discharge at these locations. MW-212 had a lower hydraulic head than the adjacent surface water.

The streambed conductivity measured at SM-3 in the unnamed stream may be inconclusive since water flowed into the bag under a neutral vertical gradient observed in the streambed piezometer and the calculated conductivity was the highest value obtained. The streambed conductivity measured at SM-4 is similar to other values measured on the Site.

Water level data along the unnamed brook at MW-212 and SM-3 suggest that the surface water may be recharging groundwater there. Shallow overburden water levels were lower than surface water elevations, suggesting the potential for surface water discharge to the groundwater.

Water level and streambed conductivity data along the unnamed brook at the MW-210 cluster suggest that the surface water and groundwater may be well-connected there. The streambed conductivity at SM-4 (4.6 feet/day) is close to the average of values measured site wide (excluding SM-3). Groundwater elevations measured at the MW-210 cluster compared with surface water elevations at SM-4 indicate the potential for groundwater discharge to surface water.

> **RSI Landfill Summary of Conditions.** Groundwater flow directions in the overburden and bedrock beneath the landfill are to the northeast with some localized flow likely toward the unnamed brook along the south side of the landfill. Groundwater discharge to the unnamed stream south of the landfill is suggested by a comparison of groundwater and surface water elevations. However, at the southeast corner of the landfill, the unnamed stream apparently recharges groundwater in the vicinity of an earthen dam. Vertical gradients observed in the three monitoring well clusters installed at this location suggest that the vertical component of groundwater flow is minimal at this location.

B&M Locomotive Shop Disposal Areas. Regional groundwater flow in both the overburden and bedrock appears to be towards the north-northeast in both of the B&M Locomotive Shop Disposal Areas (Figures 3-20 through 3-25). The potential for discharge to the canal that flows between Areas A and B, suggested by groundwater and surface water elevations, most likely produces a localized southeastern component of flow in Area A in at least the shallow overburden. Based on site-wide groundwater elevation contours (Figures 3-20 and 3-23), flow in the bedrock aquifer converges in the vicinity of the B&M Locomotive Shop Disposal Areas and continues to the north. Bedrock groundwater flow in this area is thought to be influenced by the bedrock topography, which rises in elevation to the east and northeast.

Hydraulic conductivities for the B&M Locomotive Shop Disposal Areas were calculated for glacial outwash, ablation till, and basal till. A summary of Kh values is presented in (Table 3-6). Values for outwash range from 14 feet/day at MW-205S to 82 feet/day at MW-206S (Table 3-6). The one value reported for ablation till (MW-204S), 28 feet/day, is higher than is typically expected for glacial till and may be attributable to larger proportions of gravel in the till reported in samples logged at this location. The one value reported for basal till at MW-204D, 0.02 feet/day, was the lowest value for basal till reported on the Site, indicating that unit may contain higher proportions of silt and clay at this location. Hydraulic conductivity values for the bedrock were similar at all three locations and ranged from 0.31 to 0.88 feet/day.

Horizontal hydraulic gradients between the B&M Locomotive Shop Disposal Areas, A and B, differ by about an order of magnitude with the gradients in both overburden and bedrock being higher in Area B. This difference is most likely related to the presence of basal till underlying Area B (Table 3-8). Seepage velocities within the B&M Locomotive Shop Disposal Areas range from 0.2 to 0.02 feet/day in the overburden to 0.06 to 0.006 feet/day in bedrock. Exceptionally high seepage values calculated for the deep overburden in Area A may be due to high Kh values, for which only one value was available.

Seepage velocities did not vary significantly between April and August 1995, except in ablation till when they varied by 0.37 feet/day. Maximum values for the B&M Locomotive Shop Disposal Areas occurred in the glacial outwash, where values varied from a minimum of 0.39 feet/day to 0.43 feet/day.

Downward vertical gradients, measured consistently at the MW-204 cluster in the upgradient portion of Area B, indicate that the shallow overburden is recharging the deep overburden at this location. The steepening of the vertical gradient between the deep overburden and bedrock is due to the low hydraulic conductivity of the basal till, which most likely acts as a confining layer at this location.

Similar vertical gradients observed at the MW-205 and MW-206 clusters are slight but indicate some preferential flow through the deep overburden aquifer from both the shallow overburden and the bedrock. The change in magnitude of vertical gradients from those observed at the MW-204 cluster is attributable to the change in geological conditions, including the absence of till at lower elevations.

Surface water elevations measured at two seepage meter locations in the unnamed stream, SM-7 and SM-8, indicate the potential for groundwater discharge from both overburden and bedrock. Streambed piezometers and seepage meters monitored at SM-7 and SM-8 indicate that some discharge of groundwater to surface water is occurring but may be limited as streambed conductivities are low, most likely due to high proportions of silt noted in the unnamed streambed at this location. Since, as discussed above, vertical gradients between the shallow and deep overburden near the stream suggest some downward movement, it is likely that shallow groundwater discharges to the unnamed stream where possible and otherwise may move down into the deep overburden.

> **B&M Locomotive Shop Disposal Areas Summary of Conditions.** Bedrock and overburden groundwater flow appears to be to the north-northeast in both Area A and B with some localized flow influenced by the unnamed stream. Discharge to the unnamed stream from both overburden and bedrock was suggested by comparing groundwater and surface water elevation data. Area B is underlain by basal till not present at Area A which appears to cause a shallowing of the hydraulic gradient in both overburden and bedrock in Area A. Vertical gradients measured at the three monitoring wells installed in Areas A and B indicate a potential preferential groundwater pathway through the deep overburden at this location.

Old B&M Oil/Sludge Recycling Area. Groundwater flow directions in the shallow overburden beneath the Old B&M Oil/Sludge Recycling Area are consistently to the north/northeast, as shown in Figures 3-22 and 3-25). Groundwater flow in the deep overburden is more easterly (Figures 3-21 and 3-24) and may be affected by the bedrock trough that partially underlies the area trending approximately east-west. The bedrock groundwater flow direction is to the northeast (Figures 3-20 and 3-23). Groundwater elevation contours, shown in the figures referenced above, indicate that the MW-200 cluster is upgradient of the Old B&M Oil/Sludge Recycling Area as well as upgradient of the Site.

Hydraulic conductivities reported for wells screened in glacial outwash in the Old B&M Oil/Sludge Recycling Area ranged from 14 to 62 feet/day.

Several shallow overburden monitoring wells had to be screened across more than one unit due to the presence of peat in the section. Values of Kh from these wells (MW-201S and MW-203S) were similar to values obtained from wells screened only in outwash. The one value reported for basal till, 1.2 feet/day at MW-201D, was the highest value reported from basal till on the Site. Bedrock Kh values ranged from 0.095 to 4.4 feet/day.

Horizontal hydraulic gradients within the Old B&M Oil/Sludge Recycling Area are similar for the overburden and bedrock and are on the order of 0.001 to 0.003 feet/feet (Table 3-8). Variations in horizontal hydraulic gradients between April and August 1995 are on the order of 0.0003 and 0.0012 feet/feet. Seepage velocities within the Old B&M Oil/Sludge Recycling Area vary between 0.002 feet/day in bedrock and approximately 0.05 feet/day in overburden (Table 3-7).

Vertical gradients measured in monitoring well clusters in the vicinity of the Old B&M Oil/Sludge Recycling Area indicate that, upgradient of the area, at the MW-200 cluster, groundwater flows downward from shallow to deep overburden and from deep overburden to bedrock. In the more downgradient portion of the Site, at the MW-202 and MW-203 clusters, shallow overburden groundwater was observed consistently to flow downward toward the deep overburden, while bedrock groundwater was consistently found to flow upward, also toward the deep overburden. These observations suggest that the deep overburden may be a preferential flow path in this portion of the Site.

The influence of surface water bodies on groundwater flow in the vicinity of the Old B&M Oil/Sludge Recycling Area is expected to be minimal. Drainage ditches to the northwest of the area direct surface water runoff from the former recycling area toward the unnamed stream on the west side of the Site. Groundwater elevation contours in the vicinity of the former recycling area do not suggest flow in the direction of the drainage ditches.

Old B&M Oil/Sludge Recycling Area Summary of Conditions. The direction of groundwater flow in the shallow overburden was observed to be to the northeast and east. Groundwater flow in deep overburden was found to be more easterly and may be influenced by a trough in the bedrock surface. Bedrock groundwater flow was found to be to the northeast. Groundwater elevation contours in the vicinity of the recycling area do not suggest direct flow toward a surface water body. The presence of basal till just south of this area causes a steepening of the hydraulic gradient upgradient of the area. Vertical hydraulic gradients measured in the three monitoring wells installed at this location suggest that the deep overburden is a preferential pathway for groundwater flow.

Asbestos Lagoons. Shallow overburden groundwater flow in the vicinity of the Asbestos Lagoons is divided, with flow to the northwest towards the Middlesex Canal and some flow to the northeast, parallel to the regional groundwater flow direction observed elsewhere on the Site.

Shallow groundwater elevation contours for April 1995 (Figure 3-22) indicate the potential for mounding in the vicinity of the Asbestos Lagoons. In August 1995 (Figure 3-25), when water levels were lower, the mounding was still present though less pronounced. The deep overburden groundwater also observes a divide, similar to that described for the shallow overburden groundwater. The divide is more prominent in the August 1995 data.

Groundwater flow in the bedrock is generally to northeast in the vicinity of the Asbestos Lagoons, with some flow to the northwest along the western edge of the lagoons.

Overburden hydraulic conductivities for the Asbestos Lagoons could not be determined because the wells recovered quickly during slug testing at MW-208S and MW-208D. Response curves for these wells, which had very quick recovery times, could not be used to calculate the linear regression used to derive Kh. Hydraulic conductivities for existing OW wells screened in glacial outwash range from 27 to 171 feet/day. Bedrock hydraulic conductivities for MW-208B and MW-209B were 0.87 and 0.65 feet/day respectively.

Horizontal hydraulic gradients within the Asbestos Lagoons vary from minimum values of 0.001 to 0.003. Seepage velocities in the Asbestos Lagoons vary between minimum values of 0.03 feet/day in bedrock and 0.1 to 0.6 feet/day in overburden.

Vertical gradients measured in existing and new monitoring well clusters suggest that the component of vertical flow may be minimal at this location.

The relationship between surface water and groundwater at the Asbestos Lagoons was assessed using vertical gradient and stream-bed conductivity data from OW-09 through OW-12, SM-5, and SM-6. According to the water levels in the monitoring wells and the adjacent seepage meters (SM-6), bedrock and overburden groundwater potentially discharge to the Middlesex Canal at this location. Low stream conductivities measured at SM-5 and SM-6 tend to suggest that groundwater and surface water may be less connected than at other areas on the Site.

> **Asbestos Lagoons Summary of Conditions.** Shallow overburden groundwater flow in the vicinity of the Asbestos Lagoons is divided with flow both towards the northwest and northeast. This divide is likely influenced by the presence of the lagoons and is observed to some extent in the deep overburden and bedrock groundwater as well. Vertical gradients were found to be slight, suggesting a minimal component of vertical flow in groundwater at this location. The potential exists for bedrock and overburden groundwater discharge to occur to the Middlesex Canal, however actual discharge may be limited due to low streambed conductivities measured in the canal.

3.3.3 Summary of Hydrogeological Conditions

Hydrogeological information presented in the previous section is summarized in Table 3-10. Groundwater at the Site is contained within overburden and bedrock. The overburden consists primarily of glacial outwash except at the southern end of the Site where basal till is found. Ablation till occurs in limited areas on the Site. Bedrock is primarily composed of the Andover Granite except at the north/northwest edge of the Site where the Nashoba Formation (schist) was encountered. A diorite dike is interpreted to exist in the southeast corner of the Site. A bedrock trough extending through the center of the Site is inferred from bedrock surface elevation data. This trough may represent the location of a former tributary of the pre-glacial Merrimack River, which is thought to have flowed along the northwestern edge of the Site. A ridge of bedrock is found along the southeastern and eastern edge of the Site. These bedrock features most likely influence groundwater flow on the Site, the ridge acting as a boundary to eastern flow and the trough conducting some groundwater flow, particularly in the deep overburden.

Groundwater flow in the overburden and bedrock is generally to the northeast in the direction of the B&M Pond and Richardson Pond. A groundwater flow divide observed in the center of the Site directs water to the northwest as well as the northeast, but is only apparent in the southern half of the Site. The northwest side of the divide is likely influenced by the Middlesex Canal but this influence changes north of the Asbestos Lagoons, coincident with the beginning of the section of the canal that was added to facilitate construction of the railroad spur.

Vertical gradients measured at monitoring well clusters on the Site are, for the most part, low and suggest that groundwater movement is much more horizontal than vertical. Although the potential exists for groundwater discharge to occur to all surface water bodies on the Site, the low vertical hydraulic gradients tend to suggest that actual discharge may be limited. This is probably the result of considerable alteration of drainage on the Site such that the nearest actual significant groundwater discharge locations are the B&M Pond and Richardson Pond. Streamflow in the Middlesex Canal and the unnamed stream were observed to be low, which also supports the concept that minimal groundwater discharge to surface water on the Site is occurring.

SECTION 4.0

NATURE AND EXTENT OF CONTAMINATION

Chemical data for surface and subsurface soil, groundwater, surface water, and sediment are presented in this section. The nature and extent of contamination at the Site were evaluated using analytical data generated for these media during the field investigation for this RI. Analytical data from this RI and the Phase 1A RI, well as information on the historical activities associated with the Iron Horse Park Industrial Park, were used to provide an understanding of the sources and extent of contamination in relation to the 10 areas of concern on the Site: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, the Contaminated Soil Area, the Asbestos Landfill, the Asbestos Lagoons, PCB Contamination, Groundwater Contamination, and Site-Wide Surface Water and Sediment Contamination.

4.1 CONTAMINANT SOURCES

The sources of organic and inorganic contamination in the environmental media investigated are primarily attributed to past industrial and railroad operations and associated disposal activities at the Iron Horse Industrial Park. Current industrial park and railroad operations may also be contributing factors. As discussed in detail in section 1.2.5, contaminants known to have been disposed of at the Site include asbestos, PCBs, solvents, and waste oils among other various industrial, manufacturing, and maintenance chemicals. In addition, the common and widespread practice of pesticide application contributed to site contamination. Municipal and commercial/industrial wastes were also landfilled in a small area between the railroad spurs and the unnamed brook.

4.2 CONTAMINANT DISTRIBUTION AND TRENDS BY MEDIA

This section discusses the nature and extent of contamination by media, focusing on analytical data obtained during this RI. In particular, recent and historical analytical data are discussed in relation to the following eight areas of concern: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, the Contaminated Soil Area, the Asbestos Lagoons, Groundwater Contamination, and Site-Wide Surface Water and Sediment Contamination. A summary of the findings of previous investigations related to PCB Contamination and the field inspection results for the Asbestos Landfill have been prepared by M&E (1994b and 1994c, respectively) and are presented in Appendix A.

Section 2.2 provided a detailed discussion of data collection and analysis procedures. Analytical data collected during this RI were validated in accordance with EPA Region I validation guidelines, as discussed in section 2.3. All analytical data generated during the RI are reported by medium and, where appropriate, sampling rounds in Appendix F. A summary of the analytical data (i.e., averages, maximum values, frequency of detection) is presented by medium in tables presented in this section of the report and is subgrouped by geographical location or disposal area, where appropriate. The treatment of analytical data to obtain summaries is described in Appendix I.

During the data evaluation process, data trends indicated that several chemicals commonly encountered in laboratory environments were sometimes detected in samples from several media. A thorough review of validation results and data trends provided strong evidence that detected values for acetone, 2-butanone (MEK), and methylene chloride in soil, surface water, and sediment are more likely to be laboratory artifacts than site-related contaminants (section 2.3.2). While these chemicals can be associated with different site activities such as railroad operations (e.g., solvents used for degreasing locomotive parts), there is no evidence to suggest that sources of these chemicals were prevalent enough to result in widespread site contamination. For these reasons, data for these chemicals are not further discussed within this section. However, detected data values are presented in summary tables since these data are used in the assessment of human health and ecological risks.

Background samples were collected from surface soil, groundwater, surface water, and sediment for comparison with samples from the areas of concern, within the same media. As was described in section 3.1.4, the Site is located within an area having many different land uses. A currently-operating industrial park is found within the site boundaries to the west of Pond Street. Other industrial uses that occur to the east of Pond Street include a grocery store warehouse that is located to the south of the Site and the active railroad tracks that are used along the northern border of the Site. Residential and recreational areas also abut the Site east and west of Pond Street, with some open forest and wetland areas intermingled. In addition, industrial use in the general vicinity of the Site has been on-going since before the early 1900s.

The background samples for all respective media were located in areas that exhibited no recent disturbance or visual evidence of past industrial or other use. However, given the past and current land uses of the Site and surrounding areas, the background locations were situated in areas that were considered representative of areas/conditions adjacent to the Site, but were not necessarily considered "pristine". Instead the selected locations were only considered as background to the other locations sampled across the Site. More detailed descriptions of the physical environments where the background locations were sited are provided in sections 4.2.1.1, 4.2.2.1, 4.2.3.1, and 4.2.4.1 (for surface soil, groundwater, surface water, and sediment, respectively).

In addition to data from the background samples that were collected, a literature search was conducted and government agencies were contacted to obtain other available data for background information. Through this effort; however, only literature data for surface soil were obtained.

4.2.1 Surface and Subsurface Soil

Surface and subsurface soil data are discussed according to the five areas of concern that were investigated: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, and the Contaminated Soil Area. As discussed in section 2.2.2.1, surface soil samples were collected from 0 to 12 inches in depth. Samples from five locations per acre were composited such that one composite sample per acre was submitted for laboratory analysis, except at the background locations, two historical locations, and at the Old B&M Oil/Sludge Recycling Area. Discrete samples were collected at the background and two historical locations. In the Old B&M Oil/Sludge Recycling Area, a drill rig was used to collect one sample per acre because of hard-packed soil and areas covered by asphalt. In asphalt-covered areas, the soil sample was collected from 0 to 12 inches below the asphalt, which had been carefully removed beforehand.

Soil boring and test pit sampling locations were chosen to further investigate waste and fill materials identified by the geophysical surveys. Sections 2.1.3 and 2.1.4 discussed the rationale for the placement of the subsurface soil locations. The number of samples collected at each soil boring and the analyses performed were dependent on whether soil recovery was sufficient, as discussed in section 2.2.2.3 One soil sample was collected from each test pit that was excavated. Surface and subsurface soil samples were submitted for analysis of the following chemical parameters:

- Volatile organic compounds (VOCs)
- Semivolatile organic compounds (SVOCs)
- Pesticides and PCBs
- Metals
- Cyanide
- Total petroleum hydrocarbons (TPH)

Test pit and soil boring data are discussed together in the following sections for ease of presentation, since data from both types of samples compare favorably and are considered to be equally representative of subsurface soil conditions. However, because of the nature of the sample collection methods described in sections 2.1.3 and 2.1.4, soil boring samples are considered to be discrete in comparison to the composited test pit samples. Soil boring samples were collected from a confined zone, defined by a 2-foot-by-3-inch-OD split spoon, while test pit samples were obtained from loose soil taken from the bucket of a backhoe. However, because of the similarity in types of analytes detected and the heterogeneous nature of the areas of concern, the discussion of subsurface soil integrates both soil boring and test pit data. When necessary, data are presented and discussed separately.

Geotechnical parameters were also analyzed for surface soil and soil borings:

- Total combustible organics; TCO (surface soil and soil boring samples only)
- Soil moisture content (surface soil and soil boring samples only)
- Grain size (soil boring samples only)
- Porosity (soil boring samples only)
- Permeability (soil boring samples only)
- Specific gravity (soil boring samples only)

The results of the geotechnical analyses for soil boring samples were discussed in section 3.2.2 and the results for surface soil samples are presented with the following surface soil discussions.

4.2.1.1 Background Surface Soil. Three background surface soil samples (SS-11, SS-12, and SS-13; Figure 2-12) were collected for comparison to surface soil samples collected from the areas of concern. The analytes detected in background surface soil samples are summarized in Table 4-1.

Background surface soil samples were collected from areas where active industrial operations were not apparent and which did not exhibit any signs of recent disturbance. Samples were collected from different settings that are representative of the area adjacent to the Site. For instance, SS-11 was collected near a baseball field in a residential area north of the Site. The vegetation in the area is characterized by low grasses and shrub growth, interspersed with mature oak, pine, and maple trees. Surface soil SS-12 was collected in an old growth stand of pine and oak trees with limited undergrowth, at an elevational high adjacent to Pond Street. The third background location, SS-13, was situated near the unnamed brook in an old growth stand of pine and oak trees. Miscellaneous surface debris such as old tires was observed; however, no signs of recent active dumping were apparent.

Volatile organic compounds, SVOCs, and PCBs were not detected in background surface soil samples. Eight different pesticides were found including the DDT group (4,4'-DDT, 4,4'-DDD, 4,4'-DDE); which throughout the rest of this report are referred to as DDT, DDD, and DDE, respectively, methoxychlor, heptachlor epoxide, endosulfan II, dieldrin, and *alpha*-chlordane. DDT was detected in the highest concentration in all background surface soil samples. Pesticide concentrations in individual samples ranged from 1.3 to 7.7 μg/kg for the DDT group and 0.27 to 2.1 μg/kg for the other pesticides.

Aluminum, iron, and magnesium (three elements from the group of major metal ions, which also includes calcium, sodium, and potassium) were detected in all background surface soil samples. Concentrations ranged from 5,350 to 9,630 mg/kg for aluminum, 4,640 to 8,350 mg/kg for iron, and 687 to 1,480 mg/kg for magnesium. Calcium was reported in one sample at 949 mg/kg. Calcium, potassium, and sodium were also detected in the other background surface soil samples; however, the data were qualified as nondetected (section 2.3.2).

Barium (9.3 to 32.0 mg/kg) and four heavy metals (arsenic, copper, manganese, and vanadium) were also detected in all background surface soil samples. The metal detected at the highest concentration was manganese (32.0 to 206 mg/kg). Arsenic concentrations ranged from 4.0 to 7.6 mg/kg. Copper concentrations ranged from 4.7 to 8.9 mg/kg and vanadium ranged from 7.2 to 13.7 mg/kg. Additionally, lead was detected at SS-11 (102 mg/kg), and zinc was detected at SS-11 and SS-12 (46.6 and 18.4 mg/kg, respectively).

Cyanide and petroleum hydrocarbons were not detected in background surface soil samples.

In summary, the detection of several pesticides at background surface soil locations demonstrates the ubiquitous nature of these types of chemicals in urban residences located near industrialized areas. While most of the pesticides detected were banned by the mid-1980s, all were widely applied on lawns and gardens or used for termite control. Prevalence of pesticides in urban and residential communities is well documented. The levels detected in the background samples are well within the ranges reported by ATSDR (1988a) for residential and urban areas and were below the Massachusetts Contingency Plan's (MCP's) reportable concentrations (MADEP, 1995) for both soil reporting classifications.

All of the metals detected in background surface soil samples were present in other soil samples from the eastern United States and Massachusetts (Table 4-2). Of the metals detected, all were within the concentration ranges listed for the eastern United States soil. Two metals, copper and lead, were detected in background soil at concentrations above those reported for Massachusetts soil; however, both metals were below the reportable concentrations listed in the MCP for both soil reporting classifications. Since metals occur naturally soil and their concentrations can vary within a small area, it was not possible to determine the significance of differences between values cited in the literature and concentrations detected in the background samples. However, because of prevalent industrial activities such as vehicular activity, metal machining, and general machine maintenance in this area, concentrations of heavy metals in soil, such as copper and lead, would be expected to be above average (ASTDR, 1988).

4.2.1.2 B&M Railroad Landfill. The B&M Railroad Landfill was originally a wetland at the edge of the B&M Pond, but was filled in with various debris by B&M Railroad, as discussed in section 1.0. Disposal activities in the landfill began sometime prior to 1938 and continued until approximately 1976 (CDM, 1987). In addition, night dumping activities are suspected to have recently occurred in the landfill (U.S. EPA, 1994b). While the types of materials disposed of are unknown, the types of wastes observed by M&E during this field investigation include creosoted railroad ties, construction debris (brick, concrete, wood, metal, and tar paper), 55-gallon drums (deteriorated or empty), coal, tires, paper, and cloth (section 3.2.2).

The topography of the landfill currently varies because of mounds and depressions created by previous excavation activities, waste that is intermixed with soil and fill, and settling/compaction. Cover material overlaying the waste was not observed. The area is covered by herbaceous growth interspersed with woody growth, primarily grey birch.

Surface Soil. Fourteen surface soil samples (SS-61 to SS-74) were collected from the B&M Railroad Landfill. The analytes detected in surface soil samples are summarized in Table 4-3. The predominant types of organic compounds and metals detected are presented in Figures 4-1 and 4-2, respectively.

The majority of surface soil samples were composited from a soil mixture consisting of dark-colored topsoil and fill, intermixed with wastes of wood, fine gravel, and coal-like residue (shiny, burnt coal pellets). One surface soil sample, SS-74, was made up of a moist, fibrous peat intermixed with wood pieces from an old railroad tie.

Organic vapor readings were measured at two of the surface soil sampling locations. Readings ranged from 9 to 40 ppm at SS-71 and from 90 to 720 ppm at SS-66. Although none of the VOCs that were analyzed for by the laboratory were detected, complex and large-chained ketones were tentatively identified in several samples.

Polycyclic aromatic hydrocarbons (PAHs) were detected at all surface soil locations. Of these, seven PAHs (phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)-fluoranthene, and benzo(a)pyrene) were detected in all 14 samples at individual concentrations ranging from 200 to 33,000 μg/kg. Nine other PAHs were detected less often, but at similar concentrations (90 to 24,000 μg/kg) in many samples. Total PAH concentrations in each sample ranged from 3,300 to 190,000 μg/kg. The highest concentrations of PAHs were found at SS-61, which is located on the western edge of the landfill. Additionally, in most samples, other larger molecular weight PAHs were reported by the laboratory as tentatively identified compounds (TICs). Petroleum hydrocarbons were also reported in all surface soil samples ranging in concentrations from 14 to 800 mg/kg. The highest petroleum hydrocarbon and PAH concentrations tended to be found in samples from the southeastern half of the landfill (Figure 4-1).

Up to three phthalate compounds were detected in seven samples: di-n-butylphthalate (390 μg/kg), bis(2-ethylhexyl)phthalate (36 to 25,000 μg/kg), and butylbenzylphthalate (1,400 to 10,000 μg/kg). Total concentrations in each sample ranged from 36 to 27,000 μg/kg. With the exception of SS-61 and SS-62, all of the locations with phthalates were situated in the southeastern half of the landfill. Carbazole was found at concentrations of 90 to 3,400 μg/kg at eight locations. In addition, isophorone, dibenzofuran, phenol, 4-methylphenol, and bis(2-chloroethyl)ether were each detected in as many as five samples at concentrations ranging up to 430 μg/kg. Like PAHs and petroleum hydrocarbons, these organic compounds were more prevalent at locations sampled in the southeastern half of the landfill.

Twenty different pesticides were detected in the surface soil samples, with between 7 and 13 different pesticides reported for each location. The types of pesticides frequently detected at higher levels include the DDT group at concentrations ranging from 5.2 to 230 μg/kg in 10 to 14 samples, endrins (endrin, endrin aldehyde, and endrin ketone) at concentrations ranging from 3 to 170 μg/kg in 7 to 11 samples, and methoxychlor at concentrations ranging from 22 to 170 μg/kg in 10 samples. Detected less often and at lower levels were chlordanes (*alpha-* and *gamma-*) at 2.5 to 13 μg/kg in 5 to 6 samples, the aldrin group (including aldrin and dieldrin) at 0.98 to 5.2 μg/kg in 1 to 7 samples, and BHCs (*alpha-*, *beta-*, *gamma-*, and *delta-*) at 0.18 to 2.5 μg/kg in 1 to 8 samples. While heptachlors, heptachlor and heptachlor epoxide, were detected at relatively low concentrations (0.46 to 9.7 μg/kg), the epoxide derivative was measured in all 14 samples.

Total pesticide concentrations in each location ranged from 42 to 758 μg/kg, with the highest total concentrations found in samples from the southeastern half of the landfill. The DDT group of pesticides, methoxychlor, and heptachlor epoxide were also detected in background surface soil, yet the mean concentrations found in surface soil samples from the landfill were found to be statistically higher (Appendix I).

Polychlorinated biphenyls (PCBs) were not detected in any of the surface soil samples.

With the exception of sodium, major metal ions were detected in each of the 14 samples at the highest concentrations. Concentrations ranged from 4,370 to 7,260 mg/kg for aluminum, 8,990 to 76,800 mg/kg for iron, 503 to 14,700 mg/kg for calcium, 1,140 to 4,300 mg/kg for magnesium, and 472 to 792 mg/kg for potassium. Sodium was also detected but was not reported because of validation qualifications (section 2.3.2). Barium (26.9 to 922 mg/kg) and six heavy metals were also found in all of the samples: arsenic (7.5 to 36 mg/kg), copper (50.4 to 1,030 mg/kg), lead (110 to 1,130 mg/kg), manganese (135 to 1,080 mg/kg), vanadium (8.7 to 34.8 mg/kg), and zinc (53.5 to 4,400 mg/kg). Other metals detected in at least one-half of the samples include cadmium (2.1 to

34.8 mg/kg), chromium (13.7 to 304 mg/kg), cobalt (3.4 to 26 mg/kg), mercury (0.26 to 3.4 mg/kg), and nickel (23.5 to 154 mg/kg). Selenium was found less frequently (4 samples) at concentrations ranging from 0.78 to 3.1 mg/kg. In addition, antimony and silver were detected at 155 and 1.2 mg/kg, respectively, at SS-66.

Between eight and eleven heavy metals were reported in each sample. Zinc was detected in the highest concentration in eight samples, followed by lead in three samples and manganese in two samples and copper in one sample. Of the metals detected, eight of the heavy metals (antimony, cadmium, chromium, cobalt, mercury, nickel, selenium, and silver) were not detected in background surface soil.

In comparison to background surface soil concentrations, calcium concentrations were as much as two times higher; vanadium and magnesium concentrations were as much as three times higher; arsenic concentrations were as much as four times higher; manganese concentrations were as much as five times higher; iron concentrations were as much as nine times higher; and lead concentrations were as much as ten times higher. Barium concentrations were from 3 to 30 times higher, zinc concentrations were more than three times higher, and copper concentrations were more than 10 times higher. The mean concentrations for surface soil samples collected from the landfill were found to be statistically higher than the mean concentration for the background surface soil samples for 10 metals: aluminum, calcium, magnesium, barium, arsenic, copper, lead, manganese, vanadium, and zinc (Appendix I).

Ten of the 14 surface soil samples had detectable concentrations of cyanide. Concentrations ranged from 0.63 to 3.6 mg/kg, with the exception of one location, SS-74, where cyanide was detected at 39 mg/kg. Location SS-74 is situated in the northeastern corner of the landfill, on the edge of the wetland. The organic content of surface soil ranged from 6.8 to 14%. Moisture content of surface soil was in the same range (5.9 to 11%).

Subsurface Soil. Fourteen soil borings (BH-01 to BH-14) and 14 test pits (TP-01 to TP-14) were conducted in the B&M Railroad Landfill. The analytes detected in subsurface soil samples from the landfill are summarized in Table 4-3. The predominant types of organic compounds and metals detected are presented in Figures 4-3 and 4-4, respectively.

Sand, slag, and gravel were generally found intermixed with topsoil and fill in both soil borings and test pits. Wood, metal, copper piping, bricks, concrete, tires, empty and deteriorated drums, coal, plastic, and glass were also observed.

Volatile organic compounds were detected in 18 samples from 16 locations. The types of VOCs found include aromatic and chlorinated VOCs, ketones, and carbon disulfide. The number of volatile compounds and their concentrations tended to be higher in the southeastern half of the landfill, although VOCs were also found to a lesser extent across the rest of the landfill. Volatile organic compounds were also detected more often above the water table, at depths ranging from 3 to 9 feet.

Aromatic VOCs, including toluene, ethylbenzene, and xylenes, were reported in less than half of the subsurface soil samples at concentrations ranging from 1 to 870 μg/kg. Toluene was detected most often (7 out of 41 samples) and in the highest concentrations (up to 870 μg/kg). In comparison, ethylbenzene and total xylene concentrations were considerably lower than toluene concentrations. In addition, 1,1,1-trichloroethane (1,1,1-TCA), chloromethane, and carbon disulfide were each reported at concentrations (1 to 8 μg/kg) less than sample quantitation limits (SQLs) in four or fewer samples from different locations. One ketone, 4-methyl-2-pentanone (MIBK), was detected from 3 to 20 μg/kg. Organic vapor readings greater than 10,000 ppm were measured during invasive activities in some of the boreholes and test pits. This suggests that VOC concentrations in subsurface soil are possibly higher than indicated by the analytical data.

Several different types of SVOCs were detected in subsurface soil including PAHs, phenolics, and phthalates. Dibenzofuran, 3-nitroaniline, and carbazole were also found. At least two PAH compounds were identified in all but four samples. More often, between 9 and 17 compounds were reported. When detected, individual PAH concentrations ranged from 39 to 16,000 μg/kg, while total concentrations in each sample ranged from 500 to 85,000 μg/kg. Petroleum hydrocarbons were detected in all samples with the exception of three test pit locations (TP-02, TP-12, and TP-13); concentrations ranged from 12 to 18,000 mg/kg. Like PAHs, elevated petroleum hydrocarbon concentrations were generally more prevalent in the southeastern half of the landfill and tended to increase with depth.

Four phthalate compounds were detected at least once in 26 samples from 20 locations: di-n-butylphthalate (230 to 8,800 μg/kg), bis(2-ethylhexyl)phthalate (BEHP) (600 to 260,000 μg/kg), di-n-octylphthalate (240 to 18,000 μg/kg), and butylbenzylphthalate (36 to 38,000 μg/kg). Bis(2-ethylhexyl)phthalate and butylbenzylphthalate were the most often found. While detected in subsurface soil samples from across the landfill, phthalates showed a tendency to occur more frequently and at higher concentrations in the southeastern half of the landfill.

In comparison to other SVOCs, phenolic compounds (phenol, 2- and 4-methylphenol, and 2,4-dimethylphenol), 3-nitroaniline, and carbazole were found less often (in three or fewer samples), yet at concentrations ranging from 65 to 9,900 μg/kg. Dibenzofuran (41 to 4,600 μg/kg) was found in 18 samples. Several large-chain hydrocarbons, including furans and ketones, were identified in most of the samples.

Pesticides were detected in 18 samples from 13 locations. The 11 pesticides detected include: the DDT group (6 to 120 μg/kg), dieldrin (5.3 to 180 μg/kg), endosulfan II (57 to 220 μg/kg), endrins (6.8 to 640 μg/kg), chlordanes (2.1 to 80 μg/kg), and *beta*- and *gamma*-BHC (2.0 to 21 μg/kg). Although concentrations were generally lower, similar types of pesticides were detected in surface soil. The number of pesticides detected in individual samples varied from one to five. Total pesticide concentrations ranged from 9.5 to 990 μg/kg for individual samples. Dieldrin was detected the most often (11 samples), whereas *gamma*-BHC and endrin were each detected in seven samples and the other pesticides were each detected in five or fewer samples. As with other organic compounds, pesticide frequency and total concentrations were more pronounced in the southeastern half of the landfill. There was, however, no distinct trend in pesticide concentrations with depth.

Twenty-two subsurface soil samples from 15 locations had detectable quantities of PCBs. The four PCB Aroclors that were detected include 1242, 1248, 1254, and 1260; the more chlorinated Aroclors were detected more often. Individual aroclor concentrations ranged from 53 to 8,600 μg/kg, and total PCB concentrations ranged from 53 to 18,000 μg/kg in each sample. With a few exceptions (BH-01 and BH-05), PCBs generally occurred in the southeastern half of the landfill. Generally, total PCB concentrations increased with depth.

Major metal ion concentrations ranged from 2,990 to 16,100 mg/kg for aluminum, 9,750 to 220,000 mg/kg for iron, 414 to 19,200 mg/kg for calcium, 914 to 8,060 mg/kg for magnesium, 370 to 902 for potassium. Sodium was detected in one subsurface soil sample (TP-04) at 2,130 mg/kg. Sodium was also detected in other subsurface soil samples but was not reported because of validation qualifications (section 2.3.2). Barium (12 to 2,430 mg/kg) and six heavy metals were found in all samples: arsenic (5.1 to 45 mg/kg), copper (39.6 to 47,100 mg/kg), lead (5.5 to 5,630 mg/kg), manganese (88.4 to 1,620 mg/kg), vanadium (6.9 to 86.05 mg/kg), and zinc (27.2 to 13,600 mg/kg). Other metals detected in at least 50% of the subsurface soil samples include: antimony (6.1 to 184 mg/kg), cadmium (0.32 to 103 mg/kg), chromium (14 to 582 mg/kg), cobalt (3.2 to 76 mg/kg), mercury (0.16 to 3.9 mg/kg), nickel (14.9 to 1,470 mg/kg), and silver (1.1 to 15.6 mg/kg). Selenium and thallium were detected less often (11 samples or fewer) at concentrations ranging from 1.9 to 5.5 mg/kg and 0.46 to 0.88 mg/kg, respectively.

Heavy metal concentrations were generally similar for most subsurface soil samples, although a few locations (BH-07, BH-08, BH-13, TP-03, TP-09, and TP-07) tended to have higher concentrations. Six to 12 heavy metals were detected in subsurface soil samples. Zinc was most frequently detected in the highest concentration. Copper was present in the highest heavy metal concentration in five samples, while lead and manganese had the highest concentrations in three samples each.

Cyanide was detected in three subsurface soil samples at concentrations ranging from 0.63 to 0.76 mg/kg. The organic content of the subsurface soil ranged from 2.8 to 40%, with the highest percentage found at BH-11 (8.0 to 10 feet). Moisture content ranged from 3.2 to 47%.

Summary of Findings. The irregular topography of the B&M Railroad Landfill is most likely the result of mounds and depressions of waste intermixed with fill. Garbage is exposed at the surface throughout the landfill, and there is no apparent cover material. Railroad ties and other miscellaneous construction debris also protrude from the surface. Herbaceous growth, which is scattered with woody growth such as grey birch, covers much of the area. Surface soil and subsurface soil sampling locations were chosen from areas known to have been disturbed. The soil boring and test pit locations were situated with respect to geophysical anomalies that suggested potential areas of buried waste.

Similar types of organic compounds, including PAHs, phthalates, and pesticides, were detected in both surface and subsurface soil from the landfill, although concentrations were generally higher in the subsurface soil. The types of organic compounds and inorganic analytes detected in the B&M Railroad Landfill are characteristic of railroad activities. PAHs, which are common components and byproducts of creosote and petroleum-based products used to preserve railroad ties (Wan, 1991) and in conjunction with other railroad-related activities, were prevalent throughout the landfill. The presence of petroleum hydrocarbons in surface and subsurface soil is also indicative of the presence of creosote and petroleum products.

Pesticides, such as the DDT group, endrins, and methoxychlor, were frequently detected in surface and subsurface soil in the landfill. While there is no available documentation of pesticide use, the presence of pesticides in site soil is expected since pesticides were regularly used along railroad rights-of-way to exterminate termites in the wooden railroad ties (ATSDR, 1989a).

PCB Aroclors were detected in deeper subsurface soil from this landfill, but were not present in surface or shallow subsurface soil. PCBs were often used in hydraulic fluids until the late 1970s (Versar, 1976). Although most of the locomotives entering the Iron Horse Industrial Park were coal-fired until the mid-1900s, hydraulic fluids were traditionally required for the locomotive braking systems. Often PCBs were used in the hydraulic fluids as a coolant.

Of the metals detected in surface soil, eight of the heavy metals (antimony, cadmium, chromium, cobalt, mercury, nickel, selenium, and silver) were not detected in background surface soil samples. Aluminum, calcium, magnesium, potassium, barium, arsenic, copper, lead, manganese, vanadium, and zinc were detected in surface soil at concentrations above the background concentrations, and the mean concentrations were statistically higher than mean background concentrations for all of these metals except potassium. Metals concentrations in subsurface soil were generally similar in subsurface soil across the landfill.

Based on the chemical characteristics exhibited in both surface and subsurface soil, the southeastern half of the landfill was generally the most contaminated with organic compounds and elevated metal concentrations. This correlates well with the findings of the geophysical surveys, since the southeastern half of the landfill was where the most anomolies were found. Similar types of organic and inorganic analytes were detected in both surface and subsurface soil. Oil-coated soils were also found in the first 4 feet of soil during the drilling of the MW-214 cluster, which is located at the eastern edge of the landfill. Although certain locations exhibited elevated levels of organic compounds and metals, the soil data suggest that the landfill contents are heterogeneous. Heterogenity in landfills is typical since the materials disposed of and contaminants released in subsurface media are not necessarily representative of the entire landfill contents, but rather of localized regions within the landfill.

4.2.1.3 RSI Landfill. As described in section 1.0, the RSI Landfill was originally used by B&M Corporation as a borrow pit for sand and gravel in the 1960s. The disposal activities at this landfill reportedly occurred over a period of three months in 1971 (Section 1.0), when municipal and light industrial wastes were disposed of by Reclamation Services, Inc. (RSI). While documentation of specific wastes disposed of are not available, the types of materials observed during the recent field investigation are typical of solid, commercial/industrial, and municipal wastes: wood, brick, rubber, plastic, coal, glass, and newspaper. The landfill also contained abundant metal objects including scrap metal items such as tire irons, crushed drums, and steel pipes.

Surface Soil. Six surface soil samples (SS-05 to SS-10) were collected from the RSI landfill. The analytes detected in surface soil samples are summarized in Table 4-4. The predominant types of organic compounds and metals detected are presented in Figures 4-5 and 4-6, respectively.

The surface of the landfill is relatively flat and is covered with sparse vegetation, primarily low grasses with some shrub growth. Railroad ties and other railroad debris are currently scattered across the surface of the landfill. There is no available documentation of cover material applied after RSI disposal operations ceased in 1971. Surface soil samples generally consisted of light-colored sandy fill that was intermixed with gravel. There was no visual evidence of unusual discoloration or staining. Organic vapor readings of up to 8 ppm were measured in surface soil.

The organic compounds detected in surface soil samples consisted of PAHs, phenolics, and pesticides. Volatile organic compounds and PCBs were not found in any of the samples. PAHs were detected in three surface soil samples: SS-06, SS-07, and SS-09. Total PAH concentrations in each sample ranged from 400 to 1,600 μg/kg. Individual concentrations of the five PAH compounds that were reported did not exceed 390 μg/kg, which is near SQLs. Maximum PAH concentrations were detected at SS-06. Petroleum hydrocarbons were reported in one sample, SS-08, at 14 mg/kg. In addition, phenol was detected at 110 and 220 μg/kg in SS-08 and SS-07, respectively.

Pesticides were detected in all six surface soil samples. Nine different pesticides were found and at least two different pesticides were reported in each sample. Total pesticide concentrations ranged from 1.1 to 9.5 μg/kg. Pesticides from the DDT group were detected the most frequently with individual concentrations ranging from 0.25 to 5.2 μg/kg. Other pesticides detected include: endosulfan II (0.51 μg/kg), endrins (0.38 to 1.4 μg/kg), heptachlor epoxide (0.5 to 0.75 μg/kg), methoxychlor (0.7 to 4.0 μg/kg), and *gamma*-chlordane (0.33 μg/kg). Similar types of pesticides were also detected in background surface soil at comparable concentrations.

Major metal ions were detected at concentrations ranging from 6,120 to 9,470 mg/kg for aluminum, 6,810 to 13,600 mg/kg for iron, 313 to 1,180 mg/kg for calcium, and 1,360 to 3,780 mg/kg for magnesium and 689 to 1,990 mg/kg for potassium. Sodium was also detected, but it was not reported because of validation qualifications (section 2.3.2). Barium (15.2 to 46 mg/kg) and six heavy metals were found in all surface soil samples: arsenic (3.9 to 4.8 mg/kg), cobalt (2.2 to 6.5 mg/kg), lead (4.0 to 248 mg/kg), manganese (131 to 212 mg/kg), vanadium (9.4 to 20.2 mg/kg), and zinc (20.4 to 59 mg/kg). In addition, chromium and copper were reported at concentrations ranging from 15.7 to 23.7 mg/kg in four samples and 10.7 to 19.7 mg/kg in five samples, respectively.

From five to seven heavy metals were detected in each surface soil sample. The highest heavy metal concentrations were associated with manganese, except for SS-08, in which lead concentrations were higher.

Of the metals detected in surface soil samples, potassium, chromium, and cobalt were not detected in background surface soil and aluminum, calcium, manganese, arsenic, barium, and zinc were detected in surface soil samples within the same concentration ranges as background surface soil. In comparison, iron, magnesium, copper, lead, and vanadium concentrations were as much as two times higher than background surface soil. However, no statistical differences in mean concentrations for these metals were found (Appendix I).

Cyanide was not detected. The organic content of surface soil was reported as 2.7%. Moisture content was reported as 5.8%.

Subsurface Soil. Twelve soil borings (BH-15 to BH-26) and six test pits (TP-15 to TP-20) were advanced in the RSI Landfill. The analytes detected in subsurface soil samples are summarized in Table 4-4. The predominant types of organic compounds and metals detected are presented in Figures 4-7 and 4-8, respectively.

As discussed in section 3.2.2, the geophysical surveys suggest that a smaller area within the suspected landfill boundaries exhibited features characteristic of fill or waste. In order to verify the presence and horizontal extent of the suspected buried waste, soil borings were situated both inside and outside of the area delineated by the geophysical data. Test pits were located within the area to verify and characterize the waste. The six soil borings (BH-15 to BH-20) advanced outside of the geophysical anomalies encountered natural geologic material consisting of sand or sand and gravel. Sandy fill intermixed with refuse (glass, cardboard, paper, brick, metal, and plastic) was observed in the remaining six soil borings (BH-21 to BH-26) and in all of the test pits. Organic vapor readings up to 100 ppm were measured in subsurface soil.

Organic compounds were detected at all subsurface soil locations with the exception of BH-15, BH-20, TP-15, and TP-20. Eight VOCs, including aromatic compounds (BTEX, chlorobenzene, and styrene), 1,2-dichloroethene (1,2-DCE), and carbon disulfide, were detected. Aromatic VOCs were found in 10 subsurface soil samples from nine different locations. Although ethylbenzene was the most frequently detected aromatic VOC (eight samples), concentrations were less than 11 μg/kg. One exception was BH-23 (10-12 feet), in which ethylbenzene was found at 47 μg/kg. The remaining aromatic VOCs were each detected in four or fewer samples, and with the exception of xylenes (27 to 60 μg/kg), concentrations were less than 8 μg/kg. Two less aromatic compounds (which were reported as SVOCs) were also detected: 1,2-dichlorobenzene (1,2-DCB) from 60 to 180 μg/kg in three samples and 1,4-DCB from 59 to 2,400 μg/kg in seven samples. In addition, 1,2-dichloroethene (1,2-DCE) and carbon disulfide were detected in three samples at concentrations up to 6 μg/kg. With the exception of BH-16 from 0 to 2 feet (toluene at 1 μg/kg), VOCs were only identified in subsurface soil samples where waste was observed.

Seventeen PAH compounds were detected in 21 subsurface samples from 12 locations. Ten or more individual PAHs were detected in 11 of the samples. Individual PAH concentrations ranged from 18 to 4,600 μg/kg and total PAH concentrations in each sample ranged from 44 to 15,000 μg/kg. The highest PAH concentrations occurred at TP-18, BH-23, and BH-22. Petroleum hydrocarbons were also detected in 14 samples from 10 locations at concentrations ranging from 48 to 39,000 mg/kg. Numerous long-chain alkanes such as pentacosane, heptacosane, and hexacosane were also reported as TICs in almost all of the soil boring samples. All of these types of hydrocarbons are indicative of fuel, coal tar, and/or combustion product wastes. It should be noted that PAHs, long-chain alkanes, and petroleum hydrocarbons were also detected in locations where natural geologic materials were encountered (BH-17, BH-18, and BH-19), although levels were lower than in locations where waste was evident.

Other SVOCs were detected in many samples exhibiting PAHs and petroleum hydrocarbons; however, concentrations were near to or below the SQLs. Dibenzofuran was found at 41 to 620 μg/kg in eight samples, 4-methylphenol was found at 73 to 420 μg/kg in seven samples, and carbazole was found at 30 to 205 μg/kg in nine samples. *N*-Nitrosodiphenylamine and 4-chloro-3-methylphenol were each detected in one sample at 210 and 120 μg/kg, respectively. In addition, four phthalates (di-n-butylphthalate, BEHP, di-n-octylphthalate, and butylbenzylphthalate) were reported at individual concentrations ranging from 65 to 68,000 μg/kg in 13 samples from 11 locations.

Seventeen pesticides were detected in 17 subsurface soil samples from 11 locations with total pesticide concentrations ranging from 1.8 to 1,300 μg/kg. The DDT group of pesticides were the most often detected with concentrations of 1.8 to 630 μg/kg. Pesticides found in three or more three samples include: chlordanes (1.2 to 160 μg/kg), BHCs (1.0 to 15 μg/kg), and endrins (1.8 to 28 μg/kg). Heptachlors (1.2 to 16 μg/kg) and endosulfans (4.7 to 180 μg/kg) were detected in one sample. Unlike other organic compounds, pesticides were as readily found in samples from apparently undisturbed natural soil as were found in samples where waste was observed.

PCBs were detected in 11 samples from eight locations. All of the samples were collected in the borings where waste was observed. Three PCB Aroclors were detected at individual concentrations from 74 to 2,700 μg/kg for Aroclor 1242, 31 to 890 μg/kg for Aroclor 1254, and 29 to 420 μg/kg for Aroclor 1260. Most samples contained more than one aroclor and total PCB concentrations in each sample ranged from 84 to 3,400 μg/kg. Generally, the highest concentrations of PCBs were detected from 6 to 15 feet below ground surface. PCBs were not detected in surface or shallow subsurface (0 to 6 feet) soil samples.

Major metal ion concentrations ranged from 3,200 to 7,920 mg/kg for aluminum, 5,470 to 22,800 mg/kg for iron, from 446 to 6,270 mg/kg for calcium, 1,040 to 3,010 mg/kg for magnesium, and 401 to 1,420 mg/kg for potassium. Sodium and several calcium results were detected, but were not reported because of validation qualifications (section 2.3.2). Barium from 14.1 to 155 mg/kg from 0.20 to 0.70 mg/kg and three heavy metals were also found in all subsurface soil samples: arsenic from 4.2 to 16.6 mg/kg, manganese from 69.4 to 727 mg/kg, and vanadium from 8.75 to 23.6 mg/kg. Metals detected in 20 or more subsurface soil samples include beryllium and heavy metals: cobalt (2.2 to 6.4 mg/kg), copper (8.1 to 338 mg/kg), lead (3.2 to 356 mg/kg), and zinc (18 to 605 mg/kg). Chromium was found in 13 samples at 15.4 to 42.9 mg/kg, cobalt was found in 17 samples at 2.2 to 6.4 mg/kg, and mercury was found in 11 samples at 0.04 to 0.80 mg/kg. Metals detected less often (six or fewer samples) include: antimony (4.0 to 6.3 mg/kg), cadmium (1.8 mg/kg), nickel (15.1 to 62.5 mg/kg), selenium (0.23 to 1.0 mg/kg), and silver (0.93 to 2.1 mg/kg).

Generally, more heavy metals and higher concentrations tended to correspond to locations where waste was present. The highest heavy metal concentrations occurred in both samples from BH-23 (4 to 8 feet and 10 to 12 feet). Manganese was detected in the highest concentrations, with the exception of two samples, in which the highest concentration was for zinc.

Cyanide was detected in only one sample, BH-22 (6 to 8 feet) at 0.63 mg/kg. The organic content of subsurface soil ranged from 0.33 to 4.8%. Moisture content was reported from 2.5 to 11%.

Summary of Findings. The RSI Landfill, once an old B&M Corporation sand and gravel borrow-pit, was reportedly filled with municipal and commercia/industrial wastes from RSI, Inc. during a three month period in 1971. While the suspected boundaries of the landfill have been traditionally defined by the mounded area, the geophysical surveys and invasive investigations (section 3.2.2) indicate that waste and fill are present in a more localized area in the west-central portion of the landfill.

The surface of the landfill is relatively flat and is sparsely covered with vegetative growth. Railroad-related debris is scattered across the surface. Surface soil samples consisted of sand intermixed with gravel and did not exhibit any unusual discoloration. Pesticides, which were found in all of the surface soil samples, were the most prevalent organic compounds detected. The DDT group was the primary type of pesticides found. In addition, PAHs were found at relatively low levels in a few samples. Chromium and cobalt, which were detected in surface soil from this landfill, were not found in background surface soil. Similarly, at some locations, concentrations for three heavy metals (copper, lead, and vanadium) were higher than those in background surface soil, but the mean concentrations were not statistically different (Appendix I).

Drilling and excavation of subsurface soil focused on the west-central portion of the landfill, as described above. Subsurface soil samples collected from the outer boundaries of this area consisted of sand and gravel indicative of the natural geologic material (section 3.2.2). Sandy fill intermixed with waste materials, which are indicative of municipal and commercial/industrial wastes (glass, cardboard, paper, metal, and brick), was encountered in the central portion of the landfill from depths of 0 to 15 feet.

The primary types of organic compounds detected include aromatic VOCs, PAHs, petroleum hydrocarbons, and long-chained alkanes. At the concentrations reported, these types of hydrocarbons are indicative of fuel, coal tar, and combustion wastes. However, neither oil-coat soils or free product were observed during drilling activities. Other types of organic compounds that are associated with similar hydrocarbon wastes (i.e., phenolics, furan) were occasionally present. Pesticides, PCBs, and phthalates were also found. With the exception of pesticides, organic compounds were most prevalent in subsurface soil associated with waste material, although fuel/petroleum-related hydrocarbons were also identified to a lesser degree in natural soil.

The types of materials visually observed during this investigation (paper, metal, glass) are consistent with types of materials expected in municipal waste. The abundance of fuel/petroleum-related hydrocarbons and PCBs may be related to the industrial solid wastes that were disposed of, but may also have been components of municipal wastes. Landfilling of PCBs was permitted until the late 1970s (ATSDR, 1993); the most common products being transformers, capacitors, and hydraulic fluids. Pesticides, like the types detected, were used extensively, both residentially and commercially, during the period in which this landfill was actively in use. Based on the prevalence of pesticides throughout the Site, as well as in the background and natural soil, pesticides in this landfill may be residuals of frequent and widespread insecticide applications.

Similar to the occurrence of organic compounds, subsurface soil containing waste exhibited more types of heavy metals and higher metal concentrations than natural soil. However, heavy metals (including lead and chromium) were also detected in adjacent natural geologic material. Transport processes may contribute to the presence of heavy metals in the natural soil.

4.2.1.4 B&M Locomotive Shop Disposal Areas. The B&M Locomotive Shop Disposal Areas consist of two disposal areas separated by a man-made canal which flows north into the unnamed brook. Area A, located on the north side of the canal, is approximately one acre in size. Area B, located on the south side of the canal, is approximately five acres in size. Both areas were reportedly used to dispose of various kinds of "light and dark-toned materials" until 1979 (CDM, 1987). Additionally, subsurface discharge pipes were reportedly observed at two locations near the B&M Locomotive Shop Disposal Areas, and sediment samples collected at the discharge points contained oily waste components (CDM, 1987).

The topography of Area A is irregular because of mounds and depressions created by excavation activities, waste intermixed with soil and fill, and settling/compaction of waste. Although a thin cover of topsoil/fill overlays the waste, creosoted railroad ties, old tires, and other miscellaneous locomotive debris are exposed at the surface. Sparse, low-lying grass covers much of the area, with some shrub growth throughout the disposal area. Area B topography is relatively flat and is covered primarily with light-colored sand, although there are areas of cat-tails and reed-like wetland grass adjacent to the unnamed brook.

During invasive activities, waste materials including ash, metal, plastic, rubber, wood, brick, asphalt, and glass were found in Area A. Large buried metal objects such as cast metal, a large metal spool, and a metal plate were found in Area B. Deteriorated drums and oily wastes observed in subsurface soil during the Phase 1A RI were not observed during this RI.

Surface Soil. A total of four surface soil samples (SS-01 to SS-04) were collected from the B&M Locomotive Shop Disposal Areas. One surface soil sample (SS-04) was collected from Area A, while three surface soil samples (SS-01 to SS-03) were collected from Area B. The analytes detected in surface soil samples are summarized in Tables 4-5 and 4-6. The predominant types of organic compounds and metals detected are presented in Figures 4-9 and 4-10, respectively.

Surface soil collected from Area A generally consisted of topsoil/fill darkened with organic material. Black discoloration, indicative of spent oil or fuel-related products, were observed in several areas. Area B surface soil consisted of dry sand intermixed with organic material, which gave it a dark brown color. The surface soil from Area B showed no visual signs of staining and fill/topsoil was characteristic of the top few inches. No detectable levels of organic vapors or odors were measured in surface soil from either of the disposal areas.

The predominant types of organic compounds detected in surface soil samples were PAHs, petroleum hydrocarbons, and pesticides. Neither VOCs nor PCBs were detected. Numerous PAH compounds (15) were detected in surface soil samples collected from both areas. Individual PAH concentrations ranged from 100 to 5,900 μg/kg, while total concentrations in each sample ranged from 410 to 30,000 μg/kg. The highest PAH concentrations and the largest number of PAH compounds (15) were found in SS-03, which is one of the three samples collected from Area B. Dibenzofuran and carbazole (740 and 880 μg/kg, respectively) were also detected at SS-03. Petroleum hydrocarbons were reported in all four surface soil samples at concentrations ranging from 89 to 190 μg/kg.

Twelve different pesticides were found in all four surface soil samples, with 4 to 11 different pesticides being identified in each sample. Endrin, DDD, and DDT were each detected in all four surface soil samples at concentrations ranging from 0.18 to 9.3 μg/kg. Pesticides detected in three samples include: DDE at 1.1 to 2.4 μg/kg, heptachlor epoxide at 0.69 to 1.8 μg/kg, endosulfan II at 1.2 to 1.95 μg/kg, aldrin at 0.5 to 2.8 μg/kg, and chlordanes at 0.41 to 4 μg/kg. Also detected were methoxychlor in two samples (0.89 and 19 μg/kg), and *beta*-BHC (0.96 μg/kg) and endrin ketone (5.6 μg/kg) in one sample each. Total pesticide concentrations in each sample ranged from

1.9 to 49 μg/kg; of all the samples, SS-04 (Area A) had the highest total concentration and the largest number of different pesticides. Many of the pesticides detected in these disposal areas were also detected in background surface soil at similar concentrations; however, only the concentration for heptachlor epoxide was found to be significantly higher than the mean background concentration (Appendix I).

Major metal ions were detected at concentrations ranging from 4,350 to 5,270 mg/kg for aluminum, 7,020 to 101,000 mg/kg for iron, 570 to 6,090 mg/kg for calcium, 1,370 to 4,230 mg/kg for magnesium, and 424 to 733 mg/kg for potassium. Sodium was also detected, but it was not reported because of validation qualifications. Other metals detected in all four surface soil samples include barium from 22.2 to 342 mg/kg, manganese from 99.4 to 917 mg/kg, and four other heavy metals: arsenic from 4.5 to 49.3 mg/kg, copper from 36.8 to 3,140 mg/kg, vanadium from 7.6 to 17.2 mg/kg, and zinc from 43.9 to 821 mg/kg. Chromium at 20.4 to 87.4 mg/kg, cobalt at 3.9 to 13.9 mg/kg, lead at 38.2 to 2,370 mg/kg, nickel at 14.3 to 46.5 mg/kg, and selenium at 0.88 to 5.5 mg/kg were each detected in at least two samples. Antimony (53 mg/kg), beryllium (0.85 mg/kg), cadmium (1 mg/kg), mercury (0.19 mg/kg), and thallium (0.57 mg/kg) were only detected in the surface soil sample from Area A (SS-04).

The highest heavy metal concentrations as well as the most number of heavy metals (13) were associated with SS-04, located in Area A. The other samples each contained from six to nine heavy metals. Most notably, copper (3,140 mg/kg) and lead (2,370 mg/kg) concentrations were substantially higher in SS-04 than in Area B samples (36.8 to 319 mg/kg and 38.2 to 451 mg/kg, respectively). Copper and lead were, however, the heavy metals with the highest concentrations in SS-01 and SS-03, respectively.

Of all the metals detected in surface soil from the disposal areas aluminum and vanadium were within the concentration range for background surface soil. In comparison to background concentrations, magnesium concentrations were as much as 3 times higher, arsenic and calcium concentrations were as much as 6 times higher, iron concentrations were as much as 12 times higher, barium concentrations were as much as 10 times higher, and copper concentrations were from 4 to

350 times higher. Zinc concentrations were up to 17 times higher and lead concentrations were up to 23 times higher than reported in background surface soil. The concentrations detected at SS-04 in Area A were found to be statistically higher than the mean concentrations in background surface soils, for aluminum, iron, calcium, magnesium, barium, and three heavy metals (arsenic, copper, and lead) (Appendix I). There were no significant differences between the mean concentrations in samples from Area B and background surface soil. In addition, beryllium and eight heavy metals (antimony, cadmium, chromium, cobalt, mercury, nickel, selenium, and thallium) were detected in disposal area samples, but not in background surface soil.

Cyanide was only detected in SS-04 at 0.94 mg/kg. The organic content of surface soil was reported as 6.4% and moisture content was reported as 4.2%.

Subsurface Soil. Eight soil borings (BH-27 to BH-34) and four test pits (TP-21 to TP-24) were conducted in the B&M Locomotive Shop Disposal Areas. The analytes detected in subsurface soil samples are summarized in Tables 4-5 and 4-6. The predominant types of organic compounds and metals detected are presented in Figures 4-11 and 4-12, respectively.

Soil boring and test pit sampling locations were chosen to further investigate potential waste and fill materials identified by the geophysical surveys. Subsurface soil collected from Area A consisted of fill mixed with waste materials including ash, metal, plastic, rubber, wood, brick, asphalt, and glass. M&E's recent geophysical surveys and invasive activities indicate that waste and fill are concentrated in the southern portion of Area A near the man-made canal. Large buried metal objects such as cast metal, a large metal spool, and a metal plate were found in test pits excavated in Area B.

The predominant types of organic compounds detected in subsurface soil samples from the disposal areas include PAHs, long-chain alkanes, pesticides, and petroleum hydrocarbons. A few VOCs were also detected. With the exception of TP-24 (Area A), organic compounds were detected at all of the locations sampled.

Organic vapor readings ranged from 0 to 2 ppm in Area A and from 0 to 140 ppm in Area B. Three VOCs [benzene, toluene, and tetrachloroethene (PCE)] were detected in four samples at concentrations less than 5 μg/kg.

Seventeen PAHs were detected in subsurface soil samples. Nine or more PAHs were detected in most samples. Total PAH concentrations in each sample (330 to 7,800 mg/kg) were similar between disposal areas, with the exception of BH-31 from 4 to 6 feet (150,000 mg/kg). Petroleum hydrocarbons were detected in all but one subsurface soil sample (BH-27 from 0 to 2 feet) and ranged in concentration from 16 to 2,500 mg/kg; the highest concentration occurred at BH-31 (2 to 4 feet). With few exceptions, PAHs and petroleum hydrocarbons were found in nearly all subsurface soil samples. Long-chain alkanes (i.e., pentacosane, hexacosane, and octadecane) as well as methyl-substituted PAH compounds were tentatively identified in almost all samples. Other SVOCs detected in samples from both disposal areas include: dibenzofuran in 12 samples (50 to 1,600 μg/kg) and carbazole in 9 samples (33 to 1,500 μg/kg). 2-Methylphenol (59 μg/kg) and di-n-butylphthalate (280 μg/kg) were each detected one sample (TP-23 and BH-29, respectively) from Area B.

Sixteen different pesticides, including members of the DDT group, endosulfans, endrins, and chlordanes, were detected in the disposal areas. Individual concentrations of pesticides detected were: 1.8 to 43 μg/kg for the DDT group, 12 to 13 μg/kg for methoxychlor, 0.97 to 5.5 μg/kg for heptachlor epoxide, 1.5 to 220 μg/kg for endosulfans, 1.1 to 28 for aldrin, 2.5 μg/kg for dieldrin, 1.7 to 12 μg/kg for endrins, 0.87 to 20 μg/kg for chlordanes (*alpha-* and *gamma-*); and 1.1 µg/kg for delta-BHC. As many as 10 different pesticides were detected in each of the samples. Total pesticide concentrations ranged from 1.6 to 340 μg/kg; the highest total concentration occurred at BH-31 (4 to 6 feet), which also had the highest total concentration of PAHs.

Two PCBs, Aroclor 1242 and Aroclor 1254, were reported. The detection of PCBs were specific to one location, BH-32 (Area B) at 8 to 10 feet and 10 to 12 feet. Concentrations were reported at 64.5 μg/kg for Aroclor 1242 and 95.5 μg/kg for Aroclor 1254 in BH-32 (10 to 12 feet). Aroclor 1254 was also identified at 35 μg/kg in BH-32 (8 to 10 feet).

Major metal ions were detected at concentrations ranging from 3,240 to 8,370 mg/kg for aluminum, 566 to 15,000 mg/kg for calcium, 5,150 to 195,000 mg/kg for iron, 1,140 to 6,020 mg/kg for magnesium, and 318 to 1,000 mg/kg for potassium. Sodium was detected, but was not reported because of data validation qualifications (section 2.3.2). Barium (6.2 to 299 mg/kg), manganese (75 to 968 mg/kg), and five other heavy metals were detected in all subsurface soil samples: arsenic (4.7 to 73 mg/kg), cobalt (3.9 to 20.6 mg/kg), copper (32 to 2,660 mg/kg), lead (12.5 to 8,380 mg/kg), and vanadium (6.3 to 41.1 mg/kg). Metals detected less frequently (10 to 16 samples) were: beryllium at 0.23 to 1.3 mg/kg, antimony at 3.3 to 478 mg/kg, chromium at 9.9 to 94.7 mg/kg, mercury at 0.06 to 3.0 mg/kg, nickel at 8.7 to 93.5 mg/kg, selenium at 0.51 to 19.3 mg/kg, silver at 1.1 to 11.1 mg/kg, and zinc at 74.3 to 661 mg/kg. In addition, thallium was found in six samples from 0.27 to 4.8 mg/kg.

With the exception of TP-24, 8 to 13 heavy metals were detected in subsurface soil samples. For the most part, copper and lead were the heavy metals present in the highest concentrations in most samples. There were no apparent trends in metal distribution in either of the disposal areas. The highest concentrations of heavy metals occurred in BH-27 (0 to 2 feet), which consisted of natural material. As in surface soil, copper and lead concentrations (2,660 and 8,380 mg/kg, respectively) were notably higher in BH-27 (0 to 2 feet) from Area A than in subsurface soil from Area B.

Cyanide was not detected in any subsurface soil samples. The organic content of subsurface soil ranged from 0.8 to 18%. Moisture content ranged from 6.2 to 18%.

Summary of Findings. The B&M Locomotive Shop Disposal Areas were used for the disposal of "light and dark-toned materials" until 1979. The extent of the buried waste has historically been defined by the mounded areas to the north and south of the unnamed brook. Geophysical surveys and invasive activities indicate that waste and fill materials are concentrated in the southern portion of Area A near the man-made canal and are ubiquitous throughout Area B.

Fill and fill intermixed with waste extends from the surface throughout the vertical profile of both disposal areas. However, oily wastes, which were previously observed (Phase 1A RI) in subsurface soil, were not evident. Instead, other types of materials (i.e., wood, ash, metal, plastic, and asphalt) were present. Surficially, miscellaneous debris were evident in both areas and patches of discolored surface soil and sparse vegetation were observed in Area A.

For the most part, the chemistry between the two disposal areas, as well as surface and subsurface soil, appears to be similar. Organics were detected at all surface and subsurface locations where waste or fill were observed. Pesticides, PAHs, and petroleum hydrocarbons were the most prevalent types of organic compounds detected. Petroleum hydrocarbons and PAHs, as well as long-chained alkanes, are indicative of the types of fuel/petroleum-related products that were reportedly disposed of in these areas.

The widespread prevalence of multiple types of pesticides is similar to that seen at other areas of concern within the Site and to a lesser degree in background surface soil. To a lesser extent, these same organic compounds were also found at BH-27, which was located in natural material in Area A. In contrast, no organic compounds were found in TP-24, which is situated in the central portion of Area A, to the northeast of BH-27. An isolated occurrence of PCBs was limited to one location, BH-32. Barium, beryllium, and numerous heavy metals were distributed throughout surface and subsurface soil. While no apparent trend in any specific metals were evident, the concentrations at many locations were elevated in comparison to background surface soil. In particular, both surface and subsurface soil exhibited elevated concentrations of copper and lead.

4.2.1.5 Old B&M Oil/Sludge Recycling Area. The Old B&M Oil/Sludge Recycling Area, which was established prior to 1938, was used previously for the recycling of oil. A B&M Railroad site plan dated 1972 shows two pooled areas designated as "sludge" and "oil", both of which were filled in sometime after 1973. During the Phase 1A RI, soil was visibly contaminated with oil and PAHs, and elevated lead levels were reported (CDM, 1987). Geophysical data collected during this RI further delineated the two areas with anomalies that suggested buried oil/sludge was located at the northern and southern edges of the area (section 3.2.2). In the northern area, the presence of oil/sludge was confirmed by borings, test pits, and visual observation of sludge at the ground surface. In the southern area, the presence of oil/sludge was confirmed by borings, test pits, and the observation of free product in an adjacent piezometer (P-12). The subsurface soil from both areas generally consisted of black sand/fill, black ash, layers of oily silt/clay, oil-stained soil, free product, and black slag intermixed with waste (i.e., bricks, wood, glass, and foam). However, three soil borings (BH-36, BH-43, and BH-45) were advanced in natural materials. As discussed in section 3.2.2 and shown in Figure 3-13, both of these areas extend beyond the fenced-in area on Penn Culverts property.

Surface Soil. Six surface soil samples (SS-78 to SS-83) were collected from the Old B&M Oil/Sludge Recycling Area. The analytes detected in surface soil samples are summarized in Table 4-7. The predominant types of organic compounds and metals detected are presented in Figures 4-13 and 4-14, respectively.

Currently the surface of the fenced-in area is flat and consists of hard-packed sandy fill covered by gravel. Asphalt pavement runs from the north along the eastern fence line and crosses through the center of the area. Generally, the vegetative cover is limited to sparse low-lying grass; however, much of the area is barren, sandy fill. Surface soil largely consists of a natural, light brown fill intermixed with gravel. Staining or discoloration was not observed at the ground surface; however, black sludge material was evident at the ground surface along the western fence line near soil borings BH-37 and BH-42.

Organic compounds were detected in all but one surface soil sample, SS-79, which is located in the south-central portion of the fenced-in area. The types of organic compounds that were detected in the surface soil samples were PAHs, petroleum hydrocarbons, and pesticides. The only VOC reported was carbon disulfide at 2 μg/kg in SS-78. No PCBs were detected.

PAHs were detected in three surface soil samples (SS-78, SS-80, and SS-81). Thirteen different PAHs were detected. Total PAH concentrations ranged from 440 to 1,700 μg/kg; individual concentrations were generally below SQLs (ranging from 19 to 400 μg/kg). The highest total concentration of PAHs was found at SS-78, which is situated along the fence in the southern area. Long-chained alkanes (i.e., tetracosane, octacosane) were identified in all surface soil samples.

Petroleum hydrocarbons were detected in four surface soil samples and ranged in concentration from 56 to 330 mg/kg. Dibenzofuran and carbazole were each detected once -- in SS-80 at 22 μg/kg and in SS-78 at 33 μg/kg, respectively.

Pesticides were detected in two surface soil samples (SS-78 and SS-82). Nine different pesticides were identified. Individual concentrations ranged from 3.1 to 16 μg/kg for the DDT group, 7.5 to 8.4 μg/kg for endosulfans, 2.0 to 9.8 μg/kg for endrin, 2.8 to 5.9 μg/kg for endrin ketone, and 5.1 to 5.2 μg/kg for chlordanes. Eight pesticides were found at SS-82 and three at SS-78. Total pesticide concentrations for SS-78 and SS-82 were 7.9 and 70 μg/kg, respectively.

Major metal ions were detected at concentrations ranging from 4,130 to 8,640 mg/kg for aluminum, 7,550 to 10,600 mg/kg for iron, 616 to 1,530 mg/kg for calcium, 1,950 to 2,940 mg/kg for magnesium, and 678 to 1,190 mg/kg for potassium. Sodium was detected, but was not reported because of data validation qualifications (section 2.3.2). In addition, barium (14.1 to 38.7 mg/kg), manganese (88.1 to 135 mg/kg), and five other heavy metals were detected in all samples: arsenic (6.6 to 10.8 mg/kg), copper (7.0 to 41.1 mg/kg), lead (10.8 to 362 mg/kg), vanadium (11.7 to 18.7 mg/kg), and zinc (23.7 to 133 mg/kg). Chromium from 15.6 to 18.1 mg/kg and cobalt from 3.3 to 4.8 mg/kg were each detected four to five samples. Beryllium was detected at 0.27 mg/kg in SS-82 and two heavy metals, antimony at 14.1 mg/kg and selenium at 0.5 mg/kg, were detected at SS-81 and SS-78, respectively.

Generally six to eight heavy metals were detected in each sample. With the exception of SS-81, the highest heavy metal concentrations were associated with manganese in surface soil samples. Lead was reported at the highest concentration in SS-81. Overall, the highest heavy metal concentrations tended to occur at SS-81.

Five of the metals detected were not found in background surface soil: beryllium, antimony, chromium, cobalt, and selenium. In comparison to background concentrations, lead and zinc concentrations were up to three times greater and copper concentrations were up to four times greater. The concentrations of other metals were within the ranges found in background surface soil.

Cyanide was not detected in any of the surface soil samples.

Subsurface Soil. Twelve soil borings (BH-35 to BH-46) were advanced in the Old B&M Oil/Sludge Recycling Area. The analytes detected in subsurface soil samples are summarized in Table 4-7. The predominant types of organic compounds and metals detected are presented in Figures 4-15 and 4-16, respectively.

Soil borings were placed to verify the results of the geophysical surveys that suggest the presence of two distinct areas (referred to as northern and southern) of suspected buried oil and sludge. According to boring logs, three soil borings (BH-36, BH-43, and BH-45), were not located in either of the two areas. Subsurface soil in both the northern and southern areas consisted of black sand, black ash, layers of oily silt/clay, oil-stained soil, free product, and black slag. In addition, waste materials of wood, metal, slag, bricks, glass, and foam were encountered in a few locations.

The predominant types of organic compounds that were detected in subsurface soil include aromatic VOCs, PAHs, long-chained alkanes, and petroleum hydrocarbons. All of these organic compounds are characteristic of fuel/petroleum-related products and are consistent with the types of chemicals detected during the Phase 1A RI (CDM, 1987). Pesticides were also prevalent.

Aromatic VOCs (specifically BTEX compounds) were detected in five subsurface soil samples from four locations. Concentrations of 2 μg/kg for benzene, 1 to 1,300 μg/kg for toluene, 9 to 15 μg/kg for ethylbenzene, and 58.5 μg/kg for xylenes were measured. Toluene was the most frequently detected aromatic VOC. The highest total BTEX concentrations were found in the two samples collected from BH-40 (8-10 and 10-12 feet). Samples from BH-40 were oily and exhibited organic vapor readings of greater than 1,000 ppm. For the most part, the detection of aromatic VOCs typically occurred in samples where fuel/petroleum-related hydrocarbons were prevalent. Similar types of VOCs were also detected during the Phase 1A RI (CDM, 1987).

PAHs were detected in 19 subsurface soil samples from 12 locations. Seventeen PAH compounds were identified; individual concentrations ranged from 18 to 3,800 μg/kg. Total PAH concentrations ranged from 26 to 20,000 μg/kg in each sample. Located in the northern area, BH-39 (2 to 4 feet) contained 16 PAH compounds and exhibited higher concentrations than other samples. Long-chained alkanes, such as tetracosane and octacosane, were tentatively identified in the majority of subsurface soil samples where PAH compounds were detected. Likewise, petroleum hydrocarbons were reported in 16 samples from 11 locations and ranged in concentration from 11 to 8,200 mg/kg. The highest petroleum hydrocarbon concentrations were reported in samples from the three locations in the southern area where oil was observed. Similar to the visual observations, the widespread presence of fuel/petroleum-related hydrocarbons did not show any apparent distinction between the northern and southern areas. However, oil and free product were visually observed at several locations in the southern area. This concurs with findings from the Phase 1A RI (CDM, 1987).

Dibenzofuran was detected in five samples from four locations while carbazole was detected in two samples from two locations. Concentrations ranged from 41 to 380 μg/kg for dibenzofuran and from 160 to 480 μg/kg for carbazole. These organic compounds occurred in samples that exhibited elevated concentrations of other fuel/petroleum-related hydrocarbons.

Pesticides were detected in 11 subsurface soil samples from 8 locations. Fifteen different pesticides were identified and individual concentrations ranged from 0.93 to 210 μg/kg. Types of pesticides detected include the DDT group (1.7 to 40 μg/kg), methoxychlor (12 to 210 μg/kg), heptachlor epoxide (0.93 to 3.0 μg/kg), endosulfans (1.9 to 31 μg/kg), aldrin (22 to 46 μg/kg), dieldrin (2.9 μg/kg), endrins (2 to 63 μg/kg), and chlordanes (0.98 to 27 μg/kg). As many as 11 pesticides were identified in individual samples. Total pesticide concentrations in each sample ranged from 1.7 to 550 μg/kg. Pesticides were not as widespread as fuel/petroleum-related hydrocarbons and tended to be more pronounced in the northern area.

One PCB, Aroclor 1260, was detected at 110 μg/kg in BH-44 (2 to 5 feet), located in the northern area. PCBs were not detected in other samples from this area.

Major metal ions were detected at concentrations ranging from 3,510 to 8,030 mg/kg for aluminum, 364 to 4,930 mg/kg for calcium, 3,540 to 42,100 mg/kg for iron, 970 to 3,540 mg/kg for magnesium, 443 to 1,620 for potassium, and 2,140 to 2,560 mg/kg for sodium. Barium (12.5 to 405 mg/kg), manganese (44.2 to 613 mg/kg), and vanadium (6.5 to 24 mg/kg) were found in all samples. Metals detected in thirteen or more samples include five heavy metals: arsenic (2.1 to 16.7 mg/kg), cobalt (2.1 to 8.2 mg/kg), copper (8.2 to 1,980 mg/kg), lead (8.9 to 4,120 mg/kg), and zinc (14.4 to 901 mg/kg). Metals detected in five to eight samples were antimony from 4.5 to 319 mg/kg, beryllium from 0.19 to 0.29 mg/kg, chromium from 13.1 to 43.6 mg/kg, mercury from 0.06 to 0.84 mg/kg, and selenium from 0.48 to 1.6 mg/kg. Cadmium was found in two samples at 1.2 mg/kg, while nickel was found in one sample at 45.9 mg/kg and thallium was found in three samples at 0.46 to 0.92 mg/kg.

Most samples contained between 5 and 10 heavy metals. The highest heavy metal concentrations tended to occur at locations where oil was evident. Lead and manganese were the two heavy metals usually detected at the highest concentrations in subsurface soil samples. Elevated lead concentrations were also found in subsurface soil samples collected during the Phase 1A RI (CDM, 1987).

Cyanide was not detected in any of the subsurface soil samples. The organic content of the subsurface soil was reported to range from 0.44 to 7.4%. Moisture content of subsurface soil ranged from 4.8 to 21%.

Summary of Findings. Two areas, located at the northern and southern edges of the recycling area, were further delineated by M&E through geophysical surveys, borings, and test pits (section 3.2.2). As shown in Figure 3-13, the horizontal extent of oil/sludge waste in subsurface media appears to extend beyond the fence boundaries of the Old B&M Oil/Sludge Recycling Area based on geophysical data.

Hard-packed sandy fill covered by gravel, and in some places asphalt pavement, characterize surficial conditions throughout the Site. Black sludge existed at the ground surface in one small section along the western fence line. Oil-stained soil/fill, free product, ash, and black slag were apparent in borings associated with both the northern and southern oil/sludge-contaminated areas. Organic vapors (up to 25 ppm) were also measured in soil during drilling activities to depths of 18 feet. In some instances waste (bricks, wood, glass, and foam) was also present.

For the most part, similar types of organic compounds were detected in both surface and subsurface soil from this area. The predominant types of organic compounds found were PAHs, long-chain alkanes, and petroleum hydrocarbons. Aromatic VOCs were also detected in subsurface soil, but not in surface soil. Generally, the largest number of different compounds as well as the highest concentrations were detected in subsurface soil. Similar results were mentioned in the Phase 1A RI report (CDM, 1987) and are consistent with the sludge/oil disposed of to this area.

Numerous pesticides were also found, but were not as prevalent as fuel/petroleum-related organic compounds. An isolated occurrence of PCBs at one location in the northern area suggests that PCBs were not typically disposed of and are not widespread.

As with the occurrence of organic compounds, there was an abundant assortment of heavy metals in northern and southern area soil. Although higher concentrations tended to occur in surface soil compared to subsurface soil there was no discernable pattern of distribution. Most notably lead, arsenic, copper, vanadium, and zinc were frequently detected at elevated concentrations.

4.2.1.6 Contaminated Soil Area. The Contaminated Soil Area is approximately 50 acres in size and is located primarily within the B&M Railroad trainyard. The area investigated during this RI is generally bounded by the commuter rail line to the north, the B&M Railroad Landfill, the RSI Landfill and the unnamed brook to the east, the Iron Horse Industrial Park access road (near the flag pole) to the south, and the eastern border of the BNZ (formerly Johns-Manville) property to the west. The need to investigate this area was determined based on elevated lead levels in surface soil as a result of the site-wide soil sampling program conducted during the Phase 1A RI (CDM, 1987).

Historically, the Contaminated Soil Area has been used by industries including the railroad as well as wood fabricators and plasterboard manufacturers. The area can be broadly separated into four distinct sections that include: the B&M trainyard, the McQuesten Lumberyard, the B&M maintenance buildings, and the main Iron Horse Industrial Park (i.e., Wood Fabricators, BNZ, Railroad Police, etc.). These areas are approximately defined by current activities and property ownership as shown on Figure 4-17.

The northern half of the area and a small section adjacent to the RSI Landfill are occupied by the B&M trainyard. Old locomotive engines and boxcars, miscellaneous machinery, creosote-covered railroad ties, and other miscellaneous debris litter much of this area. Although the railroad tracks are not necessarily used on each day, engines and boxcars are regularly (i.e., several days per week) moved about the trainyard. Workers frequently travel the area in vehicles. Surficially, the trainyard is relatively flat and is covered with hard-packed fill and gravel. Numerous areas are oil-soaked or stained from fuel/petroleum-related products. In addition, coal residues including ash are abundant across the area.

The McQuesten Lumberyard encompasses the easternmost portion of the Contaminated Soil Area and is approximately seven acres in size. The surface of the lumberyard is relatively flat and is covered with hard-packed fill and gravel. Some areas are covered by asphalt. Large stacks of lumber as well as creosoted telephone poles and railroad ties are stored throughout the area. Vehicles, including forklifts and trailer trucks, operate over most of the area moving and delivering lumber.

Approximately three B&M maintenance buildings are located directly south of the trainyard. Currently the northernmost building is still used for maintenance activities; however, the other dilapidated buildings are not currently in use. The makeup of this area is very similar to the trainyard itself, with visual evidence that surface soil is oil-soaked or stained and discolored. In addition to remnants of general maintenance activities, a localized area of spent coal, ash, and soot, was found near an old furnace. Its use and purpose are unknown.

The main Iron Horse Industrial Park section, located south of the maintenance area, is characterized by paved and hard-packed fill and gravel used for roadways and driveways. Buildings for Wood Fabricators, B&M Corporation, and the Railroad Police are located in this area.

Contamination Trends. Forty-six surface soil samples (SS-14 to SS-SS-59) were collected from the Contaminated Soil Area. The sampling locations, grouped by area, include:

B&M Trainyard: SS-24, SS-26, SS-30 to SS-32, and SS-42 to SS-57, SS-59

McQuesten Lumberyard: SS-22, SS-25, SS-28, SS-29, and SS-33 to SS-40

B&M Maintenance Buildings: SS-18 to SS-21, SS-23, SS-27, and SS-36

Main Iron Horse Industrial Park: SS-14 to SS-17, SS-41, SS-58

Two of the surface soil samples (SS-58 in the main Iron Horse Industrial Park section and SS-59 in the B&M trainyard) were collected from discrete locations that were historically high in lead concentrations; unlike other samples, these samples were not composited. The analytes detected in surface soil samples are summarized in Table 4-8. The predominant types of organic compounds and metals detected are presented in Figures 4-18 through 4-21.

Organic compounds that were prevalent in surface soil samples throughout the Contaminated Soil Area include PAHs, phenolics, petroleum hydrocarbons, and pesticides. Chloroethane, the only VOC detected, was found in four surface soil samples (SS-15 through SS-18); concentrations ranged from 23 to 79 $\mu g/kg$. These locations are clustered in the vicinity of the main Iron Horse Industrial Park and the railroad maintenance building areas. Chloroethane in soil is usually attributed to the degradation of other more chlorinated VOCs (i.e., 1,1,1-trichloroethane [1,1,1-TCA]; 1,2-DCE; etc.); however, the absence of more chlorinated VOCs suggests that its presence may be attributed to the use of solvents as well as general industrial activity in the area (ATSDR, 1989b). The absence of other VOCs in analytical samples is consistent with the lack of organic vapor readings during field screening.

PAHs were detected in 45 surface soil samples. Sixteen different PAHs were identified. Individual PAH concentrations ranged from 78 to 48,000 μg/kg and many of the compounds were present in numerous samples. Ten or more individual PAHs were found in 26 of the samples. Total concentrations in each sample ranged from 470 to 260,000 μg/kg. Dibenzo(b)fluoranthene was the most frequently detected in the highest concentrations.

Although PAHs were ubiquitous across the entire Contaminated Soil Area, concentrations were generally higher in locations associated with the trainyard. Likewise, more complex PAHs were also tentatively identified in many samples. Long-chained di-functional ketones, such as 9,10-anthracenedione and 5,12-naphthacenedione, were tentatively identified in almost all surface soil samples. These compounds are common break-down products of PAHs, which typically originate from incomplete coal combustion.

Other semivolatiles detected less frequently include 5 phenolics (130 to 75,000 μg/kg) in as many as 9 samples, dibenzofuran (56 to 10,000 μg/kg) in 17 samples, 2 phthalates (120 to 7,600 μg/kg) in as many as 13 samples, and carbazole (87 to 8,900 μg/kg) in 15 samples. Petroleum hydrocarbons ranged in concentration from 12 to 14,500 mg/kg in 44 surface soil samples.

Pesticides were found ubiquitously across the Contaminated Soil Area. Nineteen different pesticides were detected in surface soil samples. Individual concentrations ranged from 1.1 to 16,000 μg/kg for the DDT group, 0.21 to 5.3 μg/kg for BHCs (*alpha-*, *beta-*, and *gamma-*), 11 to 76 μg/kg for methoxychlor, 0.24 to 7.8 μg/kg for heptachlors, 0.4 to 75 μg/kg for endosulfans, 0.23 to 8.1 μg/kg for aldrin, 2.5 to 17 μg/kg for dieldrin, 0.38 to 63 μg/kg for endrins, and 0.41 to 11 μg/kg for chlordanes. DDT was the predominant pesticide in 28 samples. Methoxychlor, endrin ketone, and endosulfan sulfate were each identified in the highest concentration in several samples.

From 5 to 13 pesticides were found in each sample. With the exception of SS-51, total pesticide concentrations ranged from 11 to 260 μg/kg. The highest total concentration was found at SS-51, located in the northern most section of the trainyard, because of the presence of 16,000 μg/kg of DDT. Similar types of pesticides, including the DDT group, methoxychlor, and chlordanes, were detected in background surface soil; however, concentrations from the Contaminated Soil Area were up to an order of magnitude higher. PCBs were not detected at any surface soil location.

The range of major metal ion concentrations detected were 2,320 to 13,700 mg/kg for aluminum, 11,800 to 146,000 mg/kg for iron, 510 to 9,730 mg/kg for calcium, 682 to 6,630 mg/kg for magnesium, and 309 to 2,460 mg/kg for potassium. Sodium was also detected, but was not reported because of validation qualifications (section 2.3.2). Metals detected in 44 to 46 samples consist of barium (19.6 to 3,630 mg/kg) and seven heavy metals: arsenic (5.8 to 233 mg/kg), chromium (13.3 to 385 mg/kg), cobalt (3.2 to 15.2 mg/kg), copper (35.6 to 46,200 mg/kg), lead (69.1 to 10,800 mg/kg), manganese (105 to 3,400 mg/kg), vanadium (6.6 to 48.8 mg/kg), and zinc (29.4 to 4,170 mg/kg). Nickel was found from 12.4 to 329 mg/kg in 34 samples, mercury from 0.12 to 2.5 mg/kg in 28 samples, selenium from 0.70 to 3.9 mg/kg in 17 samples, and antimony from 7.9 to 494 mg/kg in 15 samples. In addition, 1.1 to 8.0 mg/kg of cadmium (9 samples) and 11.1 mg/kg of silver (1 sample) were reported.

From 6 to 12 heavy metals were found in individual samples. The heavy metals most frequently detected at the highest concentrations were lead in 26 samples and manganese in 16 samples. While there were pockets of areas exhibiting elevated heavy metal concentrations, discernable trends were not evident. The pockets with elevated heavy metal concentrations include locations in the maintenance building area and along the southeastern border of the trainyard as well as a few locations in McQuesten Lumberyard. At surface soil locations SS-58 and SS-59, where percent levels of lead (76,600 and 59,200 mg/kg, respectively) were previously measured during the Phase 1A RI (CDM, 1987), lead concentrations of 481 mg/kg and 9,600 mg/kg, respectively, were detected during the recent RI field investigation.

Eight of the heavy metals detected were not found in background surface soil: antimony, cadmium, chromium, cobalt, mercury, nickel, selenium, and silver. In comparison to background samples, aluminum concentrations were as much as two times greater; magnesium and vanadium concentrations were as much as four times greater; iron, calcium, and manganese concentrations were as much as 15 times greater, arsenic concentrations were as much as 30 times greater; and zinc concentrations were as much as 80 times greater. Barium and lead were up to 100 times greater in concentration. Copper concentrations, on the other hand, were between 4 and 5,000 times greater than concentrations in background surface soil. The mean concentrations for all samples in the Contaminated Soil Area were significantly higher than the mean concentrations background surface soil for aluminum, iron, calcium, magnesium, barium, arsenic, copper, and lead (Appendix I).

Cyanide was detected in six surface soil samples at concentrations ranging from 0.57 to 0.81 mg/kg. These six surface soils, SS-23 to SS-26, SS-42, and SS-43, are located on the southeastern boundary of the Contaminated Soil Area, adjacent to the RSI Landfill. Black coal-like pellets were observed in all of these samples.

Summary of Findings. The Contaminated Soil Area can be separated into four sections based on current activities and property ownership: the B&M trainyard, the McQuesten Lumberyard, the B&M maintenance buildings, and the main Iron Horse Industrial Park. Generally, the area is covered by hard-packed sandy fill and gravel. Asphalt pavement is also present in all of the areas except the trainyard. Localized areas of spent coal, ash, soot, and oil-soaked or stained and discolored surface soil were observed. Vehicles and railroad cars continue to be operated in most of the Contaminated Soil Area.

The predominant types of organic compounds found in surface soil were PAHs, petroleum hydrocarbons, and pesticides, all of which occurred ubiquitously across the entire area. Since there were no discernable patterns that might indicate specific or isolated sources, it is likely that railroad and industrial activities, many of which are ongoing, resulted in non-point source distribution of these organic compounds. Chloroethane, the only VOC detected, was found at several locations in one specific area, namely, the vicinity of the main Iron Horse Industrial Park and railroad maintenance buildings. Its presence is probably related to the use of solvents as well as other industrial activities.

In particular, PAHs, petroleum hydrocarbons, and associated organic compounds (dibenzofurans, phenolics, di-functional ketones, and carbazole) are typical of railroad and fuel/petroleum-related products used in industrial activities. The prevalence of many different types of pesticides, which is characteristic of surface soil across the entire Site and adjacent properties, suggests the widespread use of pesticides at the Site as well as in the immediate vicinity. While many of the pesticides were also found in background surface soil, higher concentrations were exhibited in the Contaminated Soil Area.

As with organic compounds, trends in metals were not apparent in the Contaminated Soil Area. Lead and manganese were the two heavy metals that were the most often detected at the highest concentrations. In particular, lead concentrations at SS-58 and SS-59 were considerably lower than the levels found during the Phase 1A RI (CDM, 1987). Many of the heavy metals that were detected (i.e., antimony, cadmium, chromium, cobalt, mercury, nickel, selenium, and silver) were not found in background surface soil. Of the metals detected in background surface soil, mean concentrations were significantly higher for aluminum, iron, calcium, magnesium, arsenic, barium, copper, lead, and zinc.

Cyanide was detected in a localized pocket along the southeastern boundary of the Contaminated Soil Area, between the B&M trainyard and the RSI Landfill.

4.2.1.7 Summary of Surface and Subsurface Soil Contamination. Organic compounds and elevated metals concentrations were found in soil throughout the Site, and the types and concentrations were largely dependent on the location within the Site. The types of organic compounds that were characteristic of most of the areas of concern include pesticides, PAHs, and petroleum hydrocarbons. Similar types of pesticides, including endrins, BHCs, and the DDT group were prevalent in surface and subsurface soil. Although pesticides were generally found at similar concentrations in surface and subsurface soil, a greater number of individual pesticides were present in subsurface soil in the different areas of concern. It is not known whether pesticides were discarded as waste in the areas of concern. Pesticides were also detected in background surface soil which demonstrates the ubiquitous nature of pesticides in urban residences located near industrialized areas. It is assumed that the presence of pesticides in background surface soil, as well as site surface and subsurface soil is attributed to widespread and general use of pesticides by both residential and industrial communities. However, in some areas of concern the concentrations detected suggest that disposal of larger quantities of pesticides have occurred. In addition, it is possible that atmospheric deposition from on-site industrial use contributed to the ubiquitous presence of pesticides.

Both PAHs and petroleum hydrocarbons are ubiquitous throughout site surface and subsurface soil; however, they are more prevalent in the areas of concern associated with railroad operations (i.e., B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, and Contaminated Soil Area). Both PAHs and petroleum hydrocarbons are common components and by-products of creosote and petroleum-based products that are likely attributable to railroad activities (i.e., creosoted railroad ties, coal residuals, etc). Other organic compounds detected, which are related to the presence of PAHs in disposal area soil include benzofurans, carbazole, and phenolics. PAHs and petroleum hydrocarbons were not present in background surface soil.

In addition to PAHs, pesticides, and petroleum hydrocarbons as mentioned above, VOCs, phenolics, and PCBs were also frequently detected in site subsurface soil. As stated earlier, the types of contaminants found in soil are specifically related to areas of concern on the Site, with the exception of PAHs, pesticides, and some metals, primarily because past disposal practices were different at each of the areas of concern. The types of contaminants found in the B&M Railroad Landfill are attributable to waste related to railroad activities (i.e., creosoted railroad ties, construction debris). Similar types of organic compounds, such as PAHs, phthalates, and pesticides were found in both surface and surface soil of this landfill. The presence of PCBs in site soil was primarily limited to soil in the B&M Railroad Landfill. PCBs were present in deeper subsurface soil, but were not present in surface or shallow subsurface soil of this landfill. Metals concentrations were generally similar between surface and subsurface soil in the B&M Railroad Landfill.

The types of organic compounds detected in the RSI Landfill are characteristic of municipal and commercial/industrial wastes. Aromatic VOCs, PAHs, petroleum hydrocarbons, and long-chained alkanes were the primary types of organic compounds detected. Pesticides, PCBs, and phthalates were also found less frequently. Generally, these organic compounds were more prevalent in subsurface soil associated with waste material; however, fuel/petroleum-related hydrocarbons were also found in natural soil but to a lesser degree. As with the organic compounds, heavy metal concentrations were generally higher in soil intermixed with waste than in natural soil.

The B&M Locomotive Shop Disposal Areas, used primarily for the disposal of railroad waste materials, had similar types of contaminants as those found in the B&M Railroad Landfill. Organic compounds, including pesticides, PAHs, and petroleum hydrocarbons were found at all surface and subsurface locations where waste or fill material was present. PCBs were also found; however only in one subsurface soil sample. No apparent trend was observed for metals; however, concentrations in surface soil were elevated above background (in particular, copper and lead in both surface and subsurface soil).

Contaminants detected in surface and subsurface soil of the Old B&M Oil/Sludge Recycling Area consisted primarily of PAHs, long-chain alkanes, and petroleum hydrocarbons. Aromatic VOCs and pesticides were detected to a lesser extent in subsurface soil; however, were not present in surface soil. Metals concentrations tended to be higher in surface soil than in subsurface soil, although no apparent trends were noted. Similar to the chemical characteristics of surface soil in other areas of concern, PAHs, petroleum hydrocarbons, and pesticides were prevalent in surface soil from the Contaminated Soil Area. No discernable patterns were found that would suggest a specific source; however, it is likely that railroad and industrial activities which are on-going over much of this area are responsible for the non-point source distribution of the contaminants. Like organic compounds, there was no apparent trend in metal concentrations in surface soil from this area.

4.2.2 Groundwater

As discussed in section 2.2.5, groundwater was sampled and analyzed at two different periods, using two different sampling and analytical methods, during this RI. In 1993, field-screening and analysis were used to characterize the groundwater at selected locations. This was followed by a more complete characterization in 1995 using laboratory analysis on groundwater collected from existing and newly-installed monitoring wells.

In September and October 1993, groundwater samples were collected from the upper portions of the shallow overburden (to a maximum of 12 feet below the ground surface) using a Geoprobe. The Geoprobe samples were immediately field-screened and analyzed for 11 VOCs using a field GC. In total, 50 groundwater screening locations were sampled in five of the areas of concern: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, and the Asbestos Lagoons. The results of field analysis provided preliminary data regarding the quality of groundwater in relation to the five areas of concern. Along with geophysical, geological, and hydrogeological data, field-screening data were used to identify existing monitoring wells and locations for the installation of new monitoring wells that were used in conjunction with the hydrogeological assessment and groundwater sampling program for each of the five areas of concern (sections 2.1.1.4 and 2.1.5).

Groundwater samples were collected from monitoring wells during two sampling rounds, March/April and July 1995. The monitoring wells that were sampled were screened in shallow and deep overburden and bedrock flow zones. A total of 77 monitoring wells were sampled using low-flow methods during each of the two 1995 rounds. The low-flow methods are designed to minimize disturbance within the water column of the well and groundwater within the vicinity of the well screen, thereby providing groundwater samples whose chemical composition are more closely representative of natural flow conditions than are obtainable by traditional bailing and other sampling techniques. Groundwater samples were submitted for laboratory analysis of the following chemical parameters:

- VOCs
- SVOCs
- Pesticides and PCBs
- Metals
- Cyanide
- TPH

Hardness, expressed as mg/l calcium carbonate ($CaCO_3$), was calculated for each groundwater sample using the calcium and magnesium concentrations reported with the metals fraction. Groundwater samples from 20 monitoring wells were also submitted during each round for the analysis of water quality parameters (WQPs) including alkalinity, chloride (Cl), nitrate/nitrite nitrogen (NO_3/NO_2), sulfate (SO_4), total phosphorus (P), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), total suspended solids (TSS), and total organic carbon (TOC). In addition, the field parameter measurements that were monitored during purging and sampling include pH, specific conductance, oxidation-reduction potential (Eh), dissolved oxygen (DO), turbidity, and temperature.

For each of the five areas of concern, groundwater data are discussed according to flow zone and their hydrogeologic relation within each of the areas of concern (Tables 4-9 and 4-10). The hydrogeologic relationship between monitoring wells most associated with each of the areas of concern was discussed in section 3.3 and refers to well clusters that are considered to be upgradient of the source area, within the source area, downgradient source area, and within the vicinity of the source area. The upgradient well clusters are considered to represent background conditions for each respective area of concern, while the water quality at the vicinity well clusters may be directly or indirectly affected by sources within each area of concern.

The data are presented separately for the two sampling rounds and provide some indication of seasonal variation in groundwater chemistry. Although the 1994/1995 winter was mild, with relatively little snow pack, the March/April round occurred during a period of spring thaws and rainfall. The July round occurred during a period of lower flow, with a one-day storm that brought heavy rains. The field-screening data for VOCs, presented in Table 4-11 and Figures 4-22 through 4-26, and historical data (CDM, 1987), presented in Table 4-12, are also discussed in the text where appropriate.

4.2.2.1 Background. Two well clusters, MW-200 and OW-05/06, were used to monitor background conditions relative to monitoring wells that were sampled during this RI. Both of these well clusters are located in areas considered to be hydrogeologically upgradient of the Site and the five areas of concern.

The MW-200 cluster consists of one shallow overburden, one deep overburden, and one bedrock well (MW-200S, MW-200D, and MW-200B, respectively). The cluster, is located in the southwest corner of the Site, in a band of forest approximately 200 feet wide, which runs in a roughly southeasterly to northwesterly direction, between railroad tracks to the southeast and a used car lot and vacant commercial land to the northwest.

The MW-200 cluster is located in a mature mixed hardwood secondary growth forest with some seasonally inundated soils in nearby depressions. The area immediately around the cluster is poorly drained, due to till lying close to the surface. A small stream is located approximately 15 feet to the east. During March/April, standing water was observed as close as 15 feet to the north, east, and south. Standing water was not observed in the immediate vicinity of the cluster during July. Ground cover consisting of dark brown organic silt, leaves, and pine needles, and no fill was encountered during well installation (section 3.2.2).

Although industrial activities are ongoing in the area surrounding the MW-200 cluster, forested land extends from the cluster site in a southwesterly direction for approximately 1,500 feet before encountering a residential area, which is currently the closest active area to the well cluster. The railroad tracks mentioned above continue into the forested area, but there is currently no indication of disturbance by industrial or residential activities in the immediate vicinity of the MW-200 cluster.

The MW-200 cluster is advanced through an area of diorite. Diorite was also encountered in other areas of the Site, although granite bedrock is more prevalent (section 3.2.2.1). Soils in the vicinity of the MW-200 cluster consist of glacial outwash, ablation till, and basal till (section 3.2.2.3). In addition, groundwater flow zones at this cluster are well connected, since purging of the bedrock well appeared to cause drawdown in the deep overburden well during the sampling rounds.

The OW-05/06 cluster consists of one deep overburden and one bedrock well (OW-06 and OW-05, respectively). Although the cluster is considered to be hydrogeologically upgradient of the Site (section 3.3), it is not directly upgradient of the five areas of concern where groundwater was being evaluated. The cluster is located at the edge of an upland forest, a few feet from the dirt access road which runs from Pond Street past the field support area towards the Iron Horse Industrial Park. Although no signs of industrial activities in the vicinity were apparent during this RI, the dirt access road regularly receives vehicular traffic. Ground cover encountered in the immediate vicinity of the well cluster consists of brown loam with sparse vegetative grass cover.

During installation of the OW-05/06 cluster, no fill was encountered (CDM, 1987). The cluster is situated in an area of granite, which is prevalent throughout the Site (section 3.2.2.1). In addition, the overburden was thinner at this location compared with the rest of the Site.

The background wells were sampled during March/April and July 1995. No samples were collected from OW-06, because it was dry during both sampling rounds. Analytes detected in the background wells are presented in Table 4-13 and in Figures 4-27 through 4-32.

Three organic compounds were detected in the background wells, all at concentrations below or near to SQLs. During the March/April round, PCB Aroclor 1260 was found at 0.02 μg/l in MW-200S and at 0.001 μg/l in the field duplicate from MW-200B. Petroleum hydrocarbons at 1.7 mg/l were also detected in the field duplicate from MW-200B in March/April. It is likely that the PCBs and petroleum hydrocarbons that were detected were adsorbed to soil or organic particles in the water column as the TSS and turbidity data that are discussed below indicate the presence of some solids. Carbon disulfide, which was found at 7 μg/l in MW-200B, was the only organic compound detected in July. No other VOCs, SVOCs, pesticides, or PCBs were detected in the background wells. For OW-05, this is consistent with results presented in the Phase 1A RI report (CDM, 1987), where the only organic compound detected at that time was bis(2-ethylhexyl)phthalate, a common laboratory artifact.

Major metal ions accounted for the majority and the highest concentrations of metals detected in the MW-200 cluster during both sampling rounds. Major metal ion concentrations were generally higher in March/April than in July, and concentrations decreased with increasing depth and groundwater flow zone, from the shallow overburden well (MW-200S), to the bedrock well (MW-200B). Calcium was detected from 10,400 to 32,300 μg/l; magnesium was detected from 1,660 to 9,230 μg/l; sodium was detected from 5,740 to 23,900 μg/l; and potassium was detected from 1,940 to 3,170 μg/l over both sampling rounds. In comparison, aluminum, and to a lesser extent iron, were noticeably absent. In most instances, the absence resulted from data being qualified as nondetected (section 2.3.2). The only reported concentration of aluminum occurred at MW-200D in March/April (1,440 μg/l), while iron was detected at MW-200D and MW-200B in March/April (1,810 and 507 μg/l, respectively), and again in July at MW-200B (442 μg/l).

As with the MW-200 cluster, aluminum and iron were not reported at OW-05 for either sampling round. Basic cation concentrations were two to three times lower than concentrations detected at the MW-200 cluster during both rounds, with concentrations ranging up to 3,870 μg/l for calcium, 1,430 μg/l for magnesium, 5,450 μg/l for sodium, and 455 μg/l for potassium.

Barium, manganese, and five heavy metals were also detected at the MW-200 cluster. Barium was detected in the shallow and deep overburden wells (10.6 to 27.1 μg/l), while manganese was detected in all of the MW-200 wells (14.5 to 1,180 μg/l). Five heavy metals were detected in MW-200D and MW-200B, while none were detected in the shallow overburden well, MW-200S. Arsenic concentrations of 45.2 and 48.5 μg/l and vanadium concentrations of 3.6 and 2.7 μg/l were detected in MW-200D during March/April and July, respectively. Copper (32.6 μg/l), lead (12.5 μg/l), and zinc (37.2 μg/l) were detected only at MW-200D in March/April. No heavy metals were detected in MW-200B in March/April, but arsenic and chromium were detected in July at 7.9 and 0.95 μg/l, respectively.

Barium (7.9 μg/l) was also detected in OW-05 during March/April, but at concentrations lower than those detected at the MW-200 cluster. Manganese was not detected in this well during either round.

The only heavy metal detected in OW-05 was zinc at 4.4 $\mu g/l$ in March/April. Previously, copper (6 $\mu g/l$) was reported in OW-05 during the Phase 1A RI (CDM, 1987), whereas zinc was not.

During March/April, groundwater samples from the three MW-200 wells were analyzed for WQPs. The deep overburden and bedrock wells were again analyzed for WQPs in July. Values for BOD and COD ranged from 4.2 to 13 mg/l, and 5 to 16 mg/l, respectively. Chloride, NO_3/NO_2, SO_4, and total P ranged from 3.4 to 25.7 mg/l, 0.02 to 0.20 mg/l, 11 to 44 mg/l, and 0.028 to 1.5 mg/l, respectively. Alkalinity ranged from 52 to 75 mg/l $CaCO_3$, and hardness values from 35 to 119 mg/l were calculated. Concentrations for TOC ranged from 0.8 to 5.2 mg/l, which is characteristic of groundwater in contact with soils having little organic content. A comparison of TDS values (66 to 206 mg/l) to TSS values (0.4 to 87 mg/l), indicates that dissolved-phase migration is more dominant transport mechanism for organic compounds or inorganic ions than colloidal or particulate migration.

For field parameters measured at the MW-200 cluster, pH values ranged from 5.9 to 7.5 over both rounds in the shallow overburden and bedrock wells. However, pH values for the deep overburden well, MW-200D, were elevated (9.3 and 10.2). The elevated pH values in MW-200D correspond with elevated turbidities of 60 and 120 NTU as well as higher TSS values (8.2 and 87 mg/l) than seen in the shallow overburden and bedrock wells. Although it is possible that bentonite might have been drawn into the well during sampling, concentrations of calcium and magnesium, which are primary components of bentonite, were not elevated in comparison to the shallow overburden and bedrock wells. Other field parameters that were measured ranged from 130 to 360 μmhos/cm for specific conductance, -153 to 178 mV for Eh, and 0.62 to 16.4 mg/l for DO.

According to hardness calculations for OW-05, water at this well was softer than that collected from the MW-200 wells. Hardness at OW-05 was calculated at 16 and 12 mg/l $CaCO_3$ for March/April and July, respectively. Based on pH values of 5.9 and 6.2, slightly more acidic conditions exist at OW-05 than at the MW-200 wells. Specific conductance during both rounds was lower than in the MW-200 cluster at 65 and 48 μmhos/cm, and Eh was higher during both rounds at 319 and 194 mV. Dissolved oxygen values (11.4 and 6.5 mg/l) were similar to those detected at the MW-200 cluster.

Summary of Findings. Three organic compounds (carbon disulfide, PCB Aroclor 1260, and petroleum hydrocarbons) were found in the background wells at concentrations near to or below SQLs. Given the concentrations reported coupled with the inconsistent detections between field duplicate samples, it is likely that the PCBs and petroleum hydrocarbons that were detected are either adsorbed to particulates in the water column or are present in dissolved phase. The TDS and TSS data indicate a higher level of dissolved-phase particles compared to solid particles. Major metal ions, barium, and manganese were the primary metals found. Five other heavy metals were also detected in deep overburden and bedrock wells: arsenic, copper, lead, zinc, and vanadium. Most site wells are located in granite bedrock, like the OW-05/06 cluster. Other wells are located in a diorite formation similar to that of the MW-200 cluster. As noted in section 3.2.2, soils derived from the decomposition of granites, which are common throughout New England, are typically considered acidic. This is consistent with the more acidic conditions detected in the OW-05/06 cluster, compared to the MW-200 cluster, which is situated in diorite.

4.2.2.2 B&M Railroad Landfill. Groundwater samples were collected from a total of 18 monitoring wells in 6 well clusters associated with the B&M Railroad Landfill (Table 4-10): upgradient wells (OW-34/35/36 cluster), wells in the source area (MW-213, MW-214, and MW-215 clusters), and wells in the vicinity of the landfill (MW-01/1A/1B/1C and OW-49/50 clusters). No wells are considered to be located directly downgradient of the landfill.

Groundwater samples were obtained during both sampling rounds from all of the wells associated with the landfill except MW-01 and MW-1B. Groundwater could not be retrieved from either MW-01 or MW-1B, and the wells are assumed to have been dry.

The analytes detected in the March/April and July sampling rounds are summarized in Tables 4-14 and Table 4-15, respectively. The predominant types of organic compounds and metals detected during both sampling rounds are presented for shallow and deep overburden and bedrock wells in Figures 4-27 through 4-32.

Upgradient Wells. No VOCs or SVOCs were detected in the three wells from the upgradient well cluster (OW-34/35/36) during either of the two sampling rounds. Petroleum hydrocarbons were also not detected. Two pesticides were detected, but only in March/April: dieldrin at 0.0006 μg/l in the shallow overburden well (OW-36) and DDT at 0.0009 μg/l in the deep overburden well (OW-35). PCB Aroclor 1260 was also detected in the shallow overburden and deep overburden wells (0.06 and 0.02 μg/l, respectively). The same Aroclor was also detected in the shallow overburden and bedrock background wells at similar concentrations, which were below SQLs. In comparison, no organic compounds were detected in these wells during the Phase 1A RI (CDM, 1987).

The major metal ions detected most often and in the highest concentrations were the basic cations (calcium, magnesium, sodium, and potassium). In general, basic cation concentrations were higher in the deep overburden and bedrock wells than in the shallow overburden well. However, concentrations in each well were similar between sampling rounds. Calcium concentrations ranged from 14,000 to 43,400 μg/l, magnesium concentrations ranged 2,040 to 12,700 μg/l, sodium concentrations ranged from 8,910 to 15,900 μg/l, and potassium concentrations ranged from 1,560 to 3,410 μg/l. In comparison, aluminum and iron were not often detected in many samples, and when detected the data were mostly qualified as nondetected during validation (section 2.3.2). Despite the validation qualifiers, the data indicates that aluminum and iron are not readily present in groundwater in the dissolved phase although they are prevalent in soils throughout the Site.

Barium and manganese were consistently reported in the same wells and at similar concentrations during both sampling rounds. Barium was detected in the shallow and deep overburden wells from 9.7 to 12.1 μg/l, while manganese was detected in only the deep overburden well from 156 to 306 μg/l. Similar manganese concentrations were reported during the Phase 1A RI (CDM, 1987). In addition, antimony was detected at 4.7 μg/l in the shallow overburden well during March/April. Copper and zinc (8.3 and 6.0 μg/l, respectively) were detected in March/April in the deep overburden well. The only heavy metal detected in the upgradient wells during July was arsenic at 3.8 μg/l in the bedrock well. Although some of the same heavy metals were reported by CDM (1987), much of that data were rejected during validation.

Cyanide was not detected in any of the upgradient wells, although it was previously detected in OW-35, the deep overburden well, at 12 μg/l (CDM, 1987). Water quality parameters were analyzed for in March/April at the three upgradient wells. Wells exhibited similar alkalinities (22 to 29 mg/l $CaCO_3$). The range of hardness values calculated for all wells was 52 to 159 mg/l. Chloride, SO_4, and NO_3/NO_2 concentrations (7.1 to 95.0 mg/l, 11 to 36 mg/l, and 0.56 to 1.45 mg/l, respectively) tended to increase with depth. Total P concentrations also increased with depth, from 0.016 mg/l in the shallow overburden well to 0.067 mg/l in the bedrock well. Biological oxygen demand was not detected, but COD was measured in the deep overburden (6 mg/l) and bedrock wells (14 mg/l). Total dissolved solid levels (79 to 241 mg/l) increased with depth and were more elevated than TSS levels (up to 0.6 mg/l). Total organic carbon was detected in only the shallow overburden well at 0.6 mg/l.

Field parameters measured during both sampling rounds indicate that field-measured geochemical conditions were relatively consistent between March/April and July. The pH values (4.8 to 7.4) were within ranges typical of northeastern geologic formations. Specific conductances values ranging from 110 to 470 μmhos/cm were measured in during the two sampling rounds, with higher values corresponding to the deep overburden and bedrock wells. Dissolved oxygen levels ranged from 0.3 to 7.9 mg/l. While Eh was relatively consistent between wells in March/April (200 to 220 mV), it was lower in July (7.0 to 136 mV). Turbidities of 6 NTU or less were recorded for all wells in March/April. In July, turbidities of 0 NTU were recorded for six wells, while turbidities less than 20 NTU were measured in the rest of the wells.

Source Area and Vicinity Wells. Nine VOCs were detected during the two sampling rounds. The VOCs were found at the three well clusters that were sampled in the source area (MW-213, MW-214, and MW-215) and in the OW-49/50 cluster, which is on the opposite side of B&M Pond, but is considered to be in the vicinity of the landfill. No VOCs were detected at MW-01/1A/1B/1C, the other vicinity well cluster located in the southwest corner of Richardson Pond. The VOCs were detected in one shallow overburden well, two deep overburden wells, and three bedrock wells. Two aromatic compounds (toluene and chlorobenzene) and six chlorinated compounds (TCE, 1,1- and 1,2-DCE, 1,1- and 1,2-DCA, and chloroform) were detected in March/April. In July, the same

VOCs were again detected at similar concentrations within the same wells. Additionally, acetone was detected at only one well in March/April.

The only shallow overburden well where VOCs were detected was MW-213S, which is located in the southeastern section of the landfill. Toluene was detected at MW-213S at 3 μg/l in March/April and at 4 μg/l in July, while acetone was detected at 15 μg/l in March/April. Likewise, only one chlorinated VOC (1,1-DCE at 5.0 μg/l) was detected in 1993 at only one of the five groundwater-screening locations, GW-45, which is about 400 feet northeast of MW-213S (Figure 4-22). In addition to the compounds analyzed, other higher molecular weight hydrocarbons were tentatively identified in MW-213S and alkyl-substituted benzene compounds were reported in MW-214S during both sampling rounds.

Volatile organic compounds were detected during both sampling rounds in two of the deep overburden wells, MW-213D and MW-214D. Chlorobenzene, the only aromatic VOC detected, was found at 4 μg/l in MW-213D during each sampling round. Five chlorinated VOCs were also detected at MW-213D during both sampling rounds: TCE; 1,1- and 1,2-DCE; and 1,1- and 1,2-DCA). Concentrations ranged from 3 to 8 μg/l, with the exception of TCE, which was detected at 53 and 39 μg/l for March/April and July, respectively. Two of the chlorinated VOCs, 1,1-DCA and 1,2-DCA, were also detected in MW-214D at concentrations of 2 to 3 μg/l. In comparison, total chlorinated VOC concentrations ranged from 73 to 54 μg/l at MW-213D and from 5 to 6 μg/l at MW-214D, in March/April and July, respectively. The identification of five larger hydrocarbon compounds at MW-213D in July also indicates the likelihood that other organic compounds exist in the groundwater. Although no VOCs were detected at OW-50 during either sampling round, a total chlorinated VOC concentration of 6 μg/l was reported in this well during the Phase 1A RI (CDM, 1987). This well is located in a cluster directly across from the B&M Pond (OW-49/OW-50) and is not considered to be directly downgradient of the landfill (section 3.3).

The same chlorinated VOCs detected in the two deep overburden wells were also detected in three bedrock wells, although at slightly higher concentrations: MW-213B, MW-215B, and OW-49. Chloroform, which was not found in any of the shallow or deep overburden wells, was also detected in the bedrock wells. In all, six chlorinated VOCs were identified in MW-213B: (TCE; 1,1- and 1,2-DCE; and 1,1- and 1,2-DCA; and chloroform); concentrations ranged from 2 to 9 $\mu g/l$ for all of the compounds except TCE, which was reported at 50 and 39 $\mu g/l$. With the exception of chloroform, the same chlorinated VOCs were also detected at similar concentrations in OW-49, located across the B&M pond. Like MW-213B, TCE concentrations (22 and 25 $\mu g/l$) were higher than concentrations reported for the other chlorinated VOCs that were detected (3 to 8 $\mu g/l$). The same chlorinated VOCs, as well as chloroform and benzene, were previously detected at a total concentration of 90 ppb in OW-49 (CDM, 1987). The only VOC detected during both sampling rounds at MW-215B, which is located in the northeastern tip of the landfill, was chloroform at 4 and 6 $\mu g/l$.

Semivolatile organic compounds were detected in three wells from each well cluster (MW-213, MW-214, and MW-215) located within the source area. No SVOCs were identified in either of the vicinity well clusters, OW-49/50 and MW-01/1A/1B/1C, although a dimethylbenzene isomer was tentatively identified in OW-50. With the exception of bis(2-ethylhexyl)phthalate (9 $\mu g/l$), which was detected only during March/April in one bedrock well, MW-215B, the nine other SVOCs that were reported during both sampling rounds occurred in two shallow overburden wells, MW-213S and MW-214S. All of these wells are located directly within the landfill. The SVOCs that were identified in the shallow overburden wells consist of PAHs, phenolics, dibenzofuran, and carbazole. Like VOCs, the same SVOCs were detected at similar concentrations in each of the wells for the two sampling rounds. In addition, several benzoic acid compounds were detected during July in MW-213B and MW-213D. Although no SVOCs were detected at the OW-49/50 cluster during either sampling round, phthalate compounds with total concentrations of 13 and 21 $\mu g/l$ were reported in the deep overburden well, OW-50, and the bedrock well, OW-49, respectively, during the Phase 1A RI (CDM, 1987).

PAHs accounted for the majority of total SVOC concentrations at MW-213S and MW-214S. Five PAHs were detected at MW-214S (naphthalene, 2-methylnaphthalene, acenaphthene, flourene, and phenanthrene), three of which were also detected at MW-213S (naphthalene, 2-methylnaphthalene, and flourene). Total PAH concentrations of 44 $\mu g/l$ were found at MW-213S during both rounds and ranged from 63 to 85 $\mu g/l$ at MW-214S. Individual concentrations ranged from 34 to 54 $\mu g/l$ for naphthalene and from 1 to 10 $\mu g/l$ for the other four PAHs.

In addition to PAHs, dibenzofuran and carbazole were detected from 3 to 6 $\mu g/l$ at MW-214S during both sampling rounds. 2-Methylphenol was also detected at MW-214S in March/April (4 $\mu g/l$), as well as at MW-213S in July (6 $\mu g/l$). 2,4-Dimethyphenol (14 $\mu g/l$) was detected during March/April at MW-213S. In addition to the target SVOCs that were identified, as many as 20 different compounds were tentatively identified in shallow overburden wells.

Like VOCs, pesticides were found in all of the well clusters associated with this landfill except MW-01/1A/1B/1C. Between the two sampling rounds, 11 different pesticides were detected at least once in seven wells; however, the individual concentrations detected (0.0001 to 0.03 $\mu g/l$) were generally less than SQLs. Although one or two pesticides were detected at most wells during each sampling round, four pesticides were found at MW-213S in March/April. The highest total pesticide concentrations (0.0290 $\mu g/l$ in March/April and 0.03 $\mu g/l$ in July) also occurred at MW-213S. Total concentrations for other wells ranged from 0.0001 to 0.0120 $\mu g/l$.

Eight pesticides were detected in the three shallow overburden wells in the landfill area. The pesticides detected at MW-213S in March/April include methoxychlor, endosulfan sulfate, dieldrin, and *alpha*-chlordane, whereas DDD was the only pesticide reported for this well in July. Dieldrin and *gamma*-chlordane were detected at MW-214S in March/April, while aldrin and endosulfan sulfate were detected in July. The only pesticide detected at MW-215S was heptachlor epoxide in March/April. Of the pesticides detected, dieldrin was also detected in the upgradient shallow overburden well in March/April; concentrations reported in wells in the landfill were higher than the concentration reported for the upgradient well.

Three pesticides were identified only during March/April in deep overburden wells. The two wells in which the pesticides were detected, MW-213D and MW-214DS, are located in the source area. Methoxychlor and endosulfan sulfate, which were detected at MW-213D, were also detected (at higher concentrations) in the shallow overburden well at this cluster (MW-213S). However, it should be noted that the field duplicate analysis conducted on this well indicates that the detection of the pesticides was not consistent. Two pesticides, heptachlor epoxide and endosulfan sulfate, were also detected at MW-214D. These pesticides differ from those found in the shallow overburden well from this cluster, MW-214S.

Pesticides were also detected in two bedrock wells. The only pesticide detected in March/April, *gamma*-chlordane, was identified at OW-49, a vicinity well. In July, *delta*-BHC was the only pesticide detected at OW-49. During the Phase 1A RI, no pesticides were detected in any of the wells from the OW-49/50/51 cluster (CDM, 1987). Also detected in July were *delta*-BHC and DDE at MW-213B. Although neither of these pesticides were reported in the shallow and deep overburden wells from the same cluster (MW-213S and MW-213D), DDD and DDT, which are closely related to DDE, were identified at MW-213S and MW-213D, respectively.

PCBs were detected in March/April in two shallow overburden wells in the landfill, MW-213S and MW-214S. The only Aroclor detected at MW-214S was 1248 at 0.15 μg/l. At MW-213S, three Aroclors were identified: 1242 at 0.04 μg/l, 1254 at 0.02 μg/l, and 1260 at 0.03 μg/l. Aroclor 1260 was found at a higher concentration (0.06 μg/l) at the upgradient shallow overburden well during the same sampling round. No PCBs were detected in July.

Petroleum hydrocarbons were not detected in any of the source or vicinity wells associated with the landfill.

Basic cations (calcium, magnesium, sodium, and potassium) were the dominant major metal ions detected in all of the wells during both sampling rounds. In general, basic cation concentrations were higher in the deep overburden and bedrock wells in comparison to shallow overburden wells, with the highest concentrations at each well cluster usually occurring in the deep overburden wells. Basic cation concentrations were relatively consistent between sampling rounds at each of the wells. Calcium concentrations ranged from 6,280 to 88,500 μg/l, magnesium concentrations ranged from 953 to 18,600 μg/l, and potassium concentrations ranged from 589 to 27,200 μg/l. For all of the well clusters except MW-213, sodium concentrations ranged from 8,210 to 39,800 μg/l. At the

MW-213 cluster, higher sodium concentrations were reported (45,000 to 219,000 μg/l), with the highest concentrations occurring in the shallow overburden well each sampling round. With the exception of the MW-213 cluster, basic cation concentrations were generally less than or within two times the concentrations found in the corresponding upgradient wells. At the MW-213 cluster, concentrations were frequently three to five times greater than upgradient well concentrations, with sodium and potassium concentrations in the shallow overburden well (MW-213S) as much as 24 times greater than in the upgradient shallow overburden well (OW-36).

In contrast, aluminum and iron concentrations were lower than basic cation concentrations at all of the wells, yet, like basic cations, concentrations were relatively consistent between sampling rounds. During March/April, aluminum was detected in only two wells at concentrations of 225 and 246 μg/l. Although aluminum was detected in most wells in July, the data were qualified as nondetected during validation. However, the detected concentrations that were qualified ranged up to only 235 μg/l. Iron was detected in nine wells in March/April at concentrations ranging from 41.6 to 45,800 μg/l. The highest concentrations occurred at three wells: 2,010 μg/l at OW-49, the bedrock well that is located across B&M Pond from the landfill; and 14,100 to 45,800 μg/l at MW-213S and MW-214S, respectively, two shallow overburden wells located in the landfill. As with aluminum, iron was detected more often in July; however, most of the data were qualified as nondetected during validation (section 2.3.2). In July, iron was detected at most wells at concentrations of up to 178 μg/l, whereas at OW-49, MW-213S, and MW-214S, the concentrations detected were 1,580, 27,900, and 42,500 μg/l, respectively.

Like basic cations, barium and manganese were detected at most wells and at similar concentrations each sampling round. The highest concentrations typically occurred in the shallow overburden wells at each well cluster (barium at 35.9 to 2,000 μg/l and manganese at 12.5 to 5,420 μg/l). The barium concentrations in the shallow overburden wells were higher for both sampling rounds than the barium concentrations found in the upgradient shallow overburden well; manganese was not detected in the upgradient shallow overburden well during either sampling round. Concentrations in deep overburden wells ranged from 5.9 to 73.2 μg/l for barium and from 1.9 to 922 μg/l for manganese. With the exception of MW-1A in March/April, barium concentrations exceeded the upgradient deep overburden well concentrations detected in both sampling rounds. Concentrations in bedrock wells ranged from 3.9 to 73.4 μg/l for barium and 43.8 to 1,260 μg/l for manganese. In comparison, neither barium nor manganese was detected in the upgradient bedrock well during either sampling round.

Over the two sampling rounds, nine other heavy metals were detected at least once, with at least one heavy metal found at each well. Heavy metals were most often detected in the shallow overburden wells and concentrations were usually higher than in any of the deep overburden or bedrock wells. During both sampling rounds, more heavy metals and higher concentrations were found in MW-213S and MW-214S than in any of the deep overburden or bedrock wells. Of the eight heavy metals detected in the shallow overburden wells, all were detected in MW-213S and/or MW-214S and lead was also detected in MW-215S. These three wells are located directly within the landfill. Arsenic (3.1 to 55.6 μg/l), cobalt (2.3 to 6.3 μg/l), lead (1.9 to 32.7 μg/l), nickel (12.0 to 21.8 μg/l), and zinc (106 to 347 μg/l) were detected in wells during both sampling rounds, while copper (57.8 μg/l) was found only in March/April and chromium (5.4 μg/l) and vanadium (0.86 to 2.5 μg/l) only in July. In comparison, none of these heavy metals were detected in the upgradient shallow overburden well.

The five heavy metals detected in deep overburden wells in March/April include chromium, cobalt, copper, lead, and zinc; cobalt and nickel were the only metals detected in July. The metals were detected primarily in the three wells located in the landfill, MW-213D, MW-214D, and MW-215D. Cobalt was also detected in the landfill wells during both sampling rounds at concentrations of 1.4 to 7.5 μg/l. In March/April, copper (54.1μg/l) and lead (8.5 μg/l) were found at MW-215D, and chromium (16.2 μg/l) was found at OW-50. During the Phase 1A RI, zinc was the only heavy metal detected in OW-50 (CDM, 1987). In comparison, copper was detected in March/April at a lower concentration in the upgradient deep overburden well. Zinc was detected in the landfill wells and in MW-1A during March/April at concentrations ranging from 3.8 to 35.9 μg/l. In comparison, the upgradient deep overburden well concentration for zinc was exceeded only at MW-215D. In addition, nickel was detected in July at 4.0 and 3.4 μg/l in MW-213D and MW-214D, respectively. None of these heavy metals were detected in the upgradient deep overburden well in July.

Arsenic and cobalt, which were detected in bedrock wells in March/April, were also detected in July along with lead, nickel, and vanadium. Arsenic was detected in March/April at 17.5 $\mu g/l$ in MW-214B and in July at 7.5 and 19.6 $\mu g/l$ in MW-215B and MW-214B, respectively. Cobalt was found in March/April at 3.3 $\mu g/l$ in OW-49 and in July at 1.7 and 3.7 $\mu g/l$ in MW-213B and OW-49, respectively. Lead was detected only in MW-215B in July (1.9 $\mu g/l$). Nickel was also detected in July at MW-213B and OW-49 (2.8 and 3.3 $\mu g/l$, respectively). During the Phase 1A RI, zinc was also detected in OW-49 (CDM, 1987). In addition, vanadium was found in July at MW-214B (0.65 $\mu g/l$). In comparison, none of these heavy metals were detected in the upgradient bedrock well during either sampling round.

Water quality parameters were analyzed at the MW-214 cluster in March/April and at the MW-214 and MW-215 clusters in July. For both sampling rounds, the alkalinity in the shallow overburden well (97 and 105 mg/l $CaCO_3$) at cluster MW-214 was higher than in the deep overburden and bedrock wells (33 to 54 mg/l $CaCO_3$); however, concentrations in each well were similar between sampling rounds. In contrast, the alkalinity in the shallow overburden well (6.0 mg/l $CaCO_3$) at cluster MW-215 was lower than alkalinities in that cluster's deep overburden and bedrock wells (33 and 40 mg/l $CaCO_3$). Hardness, which was calculated for all of the wells, varied between wells within each cluster and between well clusters during both sampling rounds, with values ranging from 26 to 298 mg/l. Chloride ranged from 8.8 to 98.7 mg/l, NO_3/NO_2 ranged up to 3.2 mg/l, SO_4 ranged from 13 to 28 mg/l, and total P ranged up to 0.65 mg/l. Cyanide was not detected in any of the wells. A BOD of 2.6 mg/l was found in MW-214S during both sampling rounds. COD was not detected in any wells. Total dissolved solids levels (98 to 322 mg/l) were considerably higher than TSS levels (0.5 to 47 mg/l) and TOC values of 0.8 to 2.7 were measured.

Field parameters measured during both sampling rounds indicate that field-measured geochemical conditions were relatively consistent between March/April and July. Values for pH of 4.9 to 8.3 were measured. A wide range of specific conductance values was measured between wells, 94 to 1,700 μmhos/cm. Specific conductance readings greater than 1,000 μmhos/cm were measured in three of the groundwater-screening locations situated in the southeastern corner of the landfill, near the MW-213 cluster. The shallow overburden well, MW-213S, had the highest conductivities recorded in any of the wells during both sampling rounds (1,500 and 1,700 μmhos/cm). Dissolved oxygen varied between wells and between sampling rounds, with levels ranging from 0.2 to 14 mg/l. Similarly, Eh measurements varied widely between wells (-160 to 378). Turbidities of 10 NTU or less were recorded during March/April and non-measurable levels were recorded in July.

Summary of Findings. As discussed in section 4.2.1.2, previous disposal activities have contributed to different types of wastes in the B&M Railroad Landfill. The numerous organic compounds and elevated metal concentrations in the surface and subsurface soils that are believed to be related to past disposal activities include: aromatic and chlorinated VOCs, PAHs, phthalates, pesticides, PCBs, and several heavy metals. Long-chained and other heavy molecular weight hydrocarbons were tentatively identified and oil-coated soils were observed to 4 feet below the ground surface at the eastern edge of the landfill. Even though no free product was observed during sampling activities or water level measurements, organic vapor readings of over 10,000 ppm were detected in subsurface soils to depths of 15 feet below the ground surface. Although these types of organic compounds were found throughout the landfill, they were generally more prevalent in the southeastern portion.

The chemical characterization of groundwater in the landfill generally corresponds with the chemical findings in soil since many of the same classes of organic compounds and metals were identified in both media. Volatile organic compounds (primarily aromatic and chlorinated), PAHs, phenolics, pesticides, and some heavy metals at elevated concentrations were identified in groundwater. These constituents were most often detected in well clusters located within the landfill, MW-213, MW-214, and MW-215, but were also found in the OW-49/50 cluster, which is across from B&M Pond yet is hydrogeologically downgradient of the landfill. Furthermore, the VOCs and elevated metal concentrations tended to be more prominent at the MW-213 and MW-214 clusters, which are located in the southeastern half of the landfill where soils were the most affected. In comparison, no organic compounds were detected at the MW-01/1A/1B/1C cluster, which is located indirectly downgradient of the landfill.

The aromatic and chlorinated VOCs detected in the landfill wells include toluene, chlorobenzene, TCE, four dichlorinated compounds, and chloroform. More VOCs were detected at the MW-213 cluster than at the other two landfill well clusters. Toluene was the only VOC detected in the shallow overburden well at the MW-213 cluster, although 1,2-DCE was detected in a nearby shallow groundwater-screening location (GW-45). During drilling of the MW-213 cluster organic, organic vapor readings of 20 to 25 ppm were measured between 44 and 49 feet below the ground surface, which coincides with the screened interval of the deep overburden well, MW-213D. Chlorinated VOCs were present in the deep overburden and bedrock wells at the MW-213 cluster; concentrations tended to be higher in the bedrock well. The same chlorinated VOCs were also detected at similar concentrations in the bedrock well at the OW-49/50 cluster, which suggests that chlorinated VOCs are migrating beyond the landfill through the deep overburden and bedrock groundwater flow zones. Furthermore, it appears that there has been long-term migration of VOCs toward the OW-49/50 cluster, since data from the Phase 1A RI report (CDM, 1987) shows the presence of similar types and concentrations of VOCs at this well cluster in 1986.

Not all of the VOCs detected in groundwater are identical to those found in soil. Contributing factors that account for the differences include: the heterogenous nature of waste and its distribution within the landfill, the long period of time that has elapsed since the landfill was actively being used, degradation processes, and the physical and chemical interactions of the soil and groundwater. There is also no indication that there is an upgradient source of VOCs since they were not detected in the upgradient well cluster (OW-34/35/36). This further suggests that the landfill soils are the source of the VOCs detected in groundwater.

Although an abundance of PAHs as well as other SVOCs, pesticides, PCBs, and petroleum hydrocarbons were found in landfill soil, they were considerably less prevalent in groundwater. Most of these types of organic compounds were detected mainly at the landfill well clusters, with the exception of two pesticides that were found only in the bedrock well across from B&M Pond, OW-49. However, all of these organic compounds were found in landfill soil. These types of organic compounds are not as mobile as VOCs because they are relatively insoluble and more readily adsorb to organic materials in the soil. The concentrations detected were relatively low.

This suggests that these compounds were adsorbed onto soil or colloidal particles that were present in the water column during sampling, except for perhaps naphthalene, the most soluble and mobile of the compounds, which was found in the highest concentrations. Pesticides and PCBs were also identified in the upgradient well cluster, although at relatively low concentrations, that were similar to those found in other wells associated with this landfill.

The metals data indicate that aluminum and iron concentrations are low in comparison to basic cation, barium, and manganese concentrations. Even though the geochemical composition of geologic formations in the area and the soils within the landfill are rich in aluminum and iron compared to other metals, the TDS, TSS, and turbidity data suggest that most of the aluminum and iron are present in particulate forms. Iron, basic cations, barium, and manganese concentrations were higher in some wells relative to upgradient wells, and mean concentrations for all of these metals were found to be significantly higher than the mean concentrations in background wells (Appendix I). Arsenic was also found at all of the landfill well clusters but was only detected in the upgradient bedrock well. However, there were no apparent trends for these metals, and while it is likely that wastes disposed of in the landfill may contribute to higher concentrations, differences in the geochemical composition of natural soils and bedrock may be equally responsible. However, the number of heavy metals and concentrations detected tended to be higher at well clusters located in the landfill than in the well clusters in the vicinity. Six heavy metals, which were not in upgradient wells, were found in landfill and vicinity wells: chromium, cobalt, lead, nickel, vanadium, and zinc. Although there was no discernable pattern to their occurrence, these metals were more prevalent in wells from the MW-213 and MW-214 cluster than in any of the other wells.

The WQP data and field parameter data did not identify any anomalies suggesting that the geochemical conditions of groundwater in wells associated with the landfill were outside of ranges typically exhibited in most natural systems. These data also indicate that groundwater conditions did not substantially differ between sampling rounds.

4.2.2.3 RSI Landfill. Groundwater samples were collected from a total of 17 monitoring wells in six well clusters associated with the RSI Landfill (Table 4-10): upgradient wells

(OW-25/26/27/MW-207B cluster), downgradient area wells (MW-210, MW-211, and MW-212, and OW-01/02/03 clusters), and wells in the vicinity (OW-07/08 cluster). No wells are located in the source area, the landfill itself, as delineated in Figure 3-13.

Groundwater samples were obtained during both sampling rounds from all of the wells associated with the landfill. The analytes detected in the March/April and July sampling rounds are summarized in Tables 4-16 and 4-17, respectively. The predominant types of organic compounds and metals detected during both sampling rounds are presented for shallow and deep overburden and bedrock wells in Figures 4-27 through 4-32.

Upgradient Wells. At least one organic compound was detected in all of the groundwater samples collected from the upgradient cluster (OW-25/26/27/MW-207B) during each of the two sampling rounds. The compounds detected include six chlorinated VOCs, one SVOC, and nine pesticides. Concentrations were generally below SQLs. None of the organic compounds detected in the upgradient samples were detected in the background wells.

No VOCs were detected in the shallow overburden (OW-26 and OW-27) or deep overburden (OW-25) wells during either sampling round. The six chlorinated VOCs that were reported were all detected in the bedrock well (MW-207B) in March/April: PCE; TCE; 1,1,1-TCA; 1,1-DCE; and 1,1- and 1,2-DCA. Three of these compounds were also detected in July (PCE, TCE, and 1,2-DCA). Concentrations between the two sampling rounds were similar, ranging from 2 to 6 μg/l. Although MW-207B had not previously been sampled, chlorinated VOCs were previously reported in the OW-25, OW-26, and OW-27 wells at total concentrations of 20 to 36 μg/l during the Phase 1A RI (CDM, 1987).

The only SVOC reported, bis(2-ethylhexyl)phthalate at 4 μg/l, was detected in OW-25 only in March/April. A phthalate (di-n-octylphthalate at 11 μg/l) was also previously detected in this well during the Phase 1A RI (CDM, 1987).

Pesticides were identified in the shallow and deep overburden wells, but not in the bedrock well. No individual pesticide was detected in the same well during both sampling rounds. The five pesticides detected in shallow overburden wells in March/April (at concentrations up to 0.008 μg/l) consist of aldrin, endrin, methoxychlor, endrin ketone, and endosulfan sulfate. Endosulfan sulfate was also detected at 0.001 μg/l during March/April in the deep overburden well. In July, four different pesticides were identified: *beta*-BHC and two members of the DDT group (DDE and DDD) in the shallow overburden wells and *alpha*-BHC and DDE in the deep overburden well. Concentrations ranged from 0.002 to 0.04 μg/l in July. Although pesticides were not detected in these wells during the Phase 1A RI (CDM, 1987), they are prevalent in surface and subsurface soil, surface water, and sediment throughout the Site.

Petroleum hydrocarbons and PCBs were not detected in any of the upgradient wells during the two sampling rounds.

Basic cations accounted for the majority and the highest concentrations of metals detected in the upgradient wells during both sampling rounds. Although concentrations were similar at each well between sampling rounds, concentrations varied widely between wells. In addition, major metal ion concentrations detected in deep overburden and bedrock wells were as much as 10 to 200 times higher than concentrations detected in the background wells. Calcium concentrations ranged from 20,600 to 359,000 μg/l, with the highest concentrations occurring in the sample from the deep overburden well; magnesium concentrations ranged from 1,460 to 194,000 μg/l, with the highest concentration occurring in the sample from the bedrock well; sodium concentrations ranged up to 279,000 μg/l, with the highest concentration occurring in one of the shallow overburden wells (OW-26); and potassium concentrations ranged up to 82,300 μg/l. The reason for the elevated concentrations is not known, but basic cation concentrations were often greater than the concentrations detected in background wells. Aluminum was not reported as it was qualified during validation (section 2.3.2); however, the qualified concentrations were less than 500 μg/l, indicating that if present, aluminum concentrations in the dissolved phase are not appreciable. Iron concentrations of up to 1,350 μg/l were found.

Barium and manganese were also detected in upgradient wells. Barium concentrations ranged from 7.6 to 15.3 μg/l in the shallow overburden wells and from 58.6 to 419 μg/l in the deep overburden and bedrock wells. Concentrations for manganese ranged from 10.4 to 205 μg/l in the shallow overburden and bedrock wells and from 3,330 to 3,740 μg/l in the deep overburden wells. Like basic cations, many of the barium and manganese concentrations were elevated in comparison to concentrations detected in background wells.

Several other heavy metals were also detected in the upgradient wells. These include arsenic, cadmium, chromium, cobalt, copper, lead, nickel, silver, thallium, vanadium, and zinc. With few exceptions, most of these heavy metals were detected during only one of the sampling rounds, with more detected in March/April than in July. Arsenic was detected in shallow overburden well during both sampling rounds at concentrations of 13.4 to 36.1 μg/l. Arsenic (3.1 μg/l) was also detected in the deep overburden well in July. Cobalt, which was detected in only the deep overburden well in March/April (5.8 μg/l), was detected from 0.53 to 9.8 μg/l in the shallow and deep overburden and bedrock wells during July. Copper was detected in the shallow overburden and bedrock wells only in March/April (3.9 to 5.9 μg/l). Lead and nickel were detected in the shallow overburden well during July at concentrations of 2.0 to 3.6 μg/l. Nickel was also found in the deep overburden well at 3.8 μg/l in July. Silver was detected in the bedrock well in March/April (25.8 μg/l) and in July (27.4 μg/l). Vanadium was detected in shallow and deep overburden wells only in July at concentrations of 0.72 to 1.7 μg/l. Cadmium and thallium were found only in the deep overburden well: cadmium (2.0 μg/l) was detected in July and thallium (9.0 μg/l) was detected in March/April.

Of the heavy metals detected at the OW-25/26/27 cluster, arsenic was the only metal reported at this well cluster during the Phase 1A RI (CDM, 1987), being detected at similar concentrations in the shallow overburden well. Five of the metals were also found in background wells: arsenic, chromium, copper, lead, and vanadium.

Cyanide was detected in the bedrock well in March/April and in the deep overburden and bedrock wells in July. Concentrations for both sampling rounds ranged from 112 to 208 μg/l. During July, WQPs were analyzed for in three of the upgradient wells, one well from each of flow zone: shallow overburden (OW-26), deep overburden (OW-25), and bedrock (MW-207B). Alkalinities ranged from 38 to 260 mg/l $CaCO_3$, with higher values occurring in the shallow and deep overburden well samples. In contrast, values calculated for hardness correspond to the increasing calcium and magnesium concentrations (57 to 5,439 mg/l as $CaCO_3$), with hardness increasing from the shallow overburden wells to the deep overburden wells to the bedrock well. Chloride and SO_4 concentrations ranged from 190 to 440 mg/l and 101 to 215 mg/l, respectively, while total P concentrations of up to 0.35 mg/l were measured and NO_3/NO_2.

Only the shallow overburden well had a detectable BOD level (1.1 mg/l), whereas COD was measured in samples from all of the wells (60 to 440 mg/l). Total dissolved solids were more elevated in the shallow overburden well (1,260 mg/l) than in the deep overburden and bedrock wells (186 and 101 mg/l, respectively). Likewise, TOCs was higher in the shallow overburden well (22 mg/l) in comparison to the deep overburden well (1.3 mg/l). No TOC was measured in the bedrock well.

Field parameters measured during both sampling rounds indicate that field-measured geochemical conditions were relatively consistent between March/April and July. The pH values were within ranges typical of northeastern geologic formations and are indicative of neutral conditions. Values of pH ranged from 6.3 to 7.0 in the deep overburden and bedrock wells. In the shallow overburden wells, pHs of 7.5 and 8.7 were measured in March/April, while pHs of 6.1 and 6.4 were measured in July. Elevated values of specific conductance were recorded in the deep overburden and bedrock wells (19,000 to 26,000 μmhos/cm) compared to the shallow overburden wells (650 to 1,500 μmhos/cm). Reduction-oxidation potentials ranged from -110 to 209 mV. Dissolved oxygen values of up to 1.4 mg/l were measured and the only turbidity value that was greater than zero was at the bedrock well in March/April (3 NTU).

Downgradient and Vicinity Wells. Aromatic and chlorinated VOCs were detected in six wells from three well clusters: three of the downgradient clusters (MW-210, MW-212, and OW-01/02/03) and the vicinity cluster (OW-07/08). No VOCs were detected in wells from the MW-211 cluster. In all, seven VOCs were detected in other wells during the two sampling rounds. The VOCs were detected in two shallow overburden, two deep overburden, and two bedrock wells. The aromatic VOCs detected consist of benzene, xylenes, and chlorobenzene. The chlorinated VOCs detected include PCE; 1,1,2,2-tetrachloroethane (1,1,2,2-PCA); TCE; 1,2-DCE; and 1,2-DCA.

Aromatic VOCs were the only VOCs detected in shallow overburden wells. During March/April, chlorobenzene was detected at 3 μg/l in MW-210S, a shallow overburden well located downgradient of the landfill, between the delineated source area and the unnamed brook. The other aromatic VOCs detected in shallow overburden well include benzene and xylenes, both of which were found during both sampling rounds but only in OW-08. Benzene was detected at 350 μg/l and xylenes were detected at 10 and 13 μg/l in March/April and July, respectively. Another aromatic VOC, 1,4-DCB, which was reported with the SVOCs, was also detected in OW-08 (3 μg/l) in July. Well OW-08 is located at the edge of the Asbestos Landfill, over 500 feet east of the RSI Landfill. Benzene and xylenes, as well as ethylbenzene, were also detected at OW-08 during the Phase IA RI (CDM, 1987).

More VOCs were detected at the groundwater-screening locations (Figure 4-23) than in the shallow overburden wells. The VOCs were identified at 5 of the 10 screening locations. Benzene was the only aromatic VOC found, occurring at three screening locations at concentrations from 0.4 to 2.6 μg/l (GW-02, GW-06, and GW-09). Unlike the shallow overburden wells, chlorinated VOCs were also detected: 1,1-DCE; *cis-* 1,2-DCE; and vinyl chloride. These compounds were found at individual concentrations of 0.4 to 8.0 μg/l in two screening locations (GW-06 and GW-10) north of the delineated landfill area. Higher concentrations of each of the chlorinated VOCs were detected in the two screening locations adjacent to the southern delineated edge of the landfill, GW-02 and GW-03. At these two locations, 1,1-DCE concentrations ranged from 59 to 61 μg/l, *cis-* 1,2-DCE was detected at 43 μg/l, and vinyl chloride concentrations ranged from 950 to 1,600 μg/l.

Although no aromatic VOCs were identified, three chlorinated VOCs were detected in the deep overburden wells. The only chlorinated VOC detected in a downgradient well was 1,1,2,2-PCA at 5 μg/l (MW-212D) during July. In the vicinity well, OW-07, TCE was detected at 23 μg/l in March/April and at 21 μg/l in July. Also detected in OW-07 during both sampling rounds was

1,2-DCE (4 and 8 μg/l). These same VOCs were also detected at similar concentrations at OW-07 during the Phase 1A RI (CDM, 1987).

Volatile organic compounds were also detected in two downgradient bedrock wells. In March/April, three VOCs were detected from 2 to 5 μg/l in OW-01 (chlorobenzene; 1,2-DCA; and TCE). In July, only TCE at 5 μg/l was detected in OW-01. The same VOCs were also found at OW-01, but at slightly higher concentrations, during the Phase 1A RI (CDM, 1987). During both sampling rounds, 1,2-dichloroethane was detected at 3 μg/l in MW-212B. Of the VOCs detected in the bedrock well samples, 1,2-DCA and TCE were also found in the upgradient wells.

Pesticides were detected in groundwater samples from all wells. Overall, 14 different pesticides were identified during one or both sampling rounds. Individual pesticide concentrations in the wells ranged from 0.0002 to 0.01 μg/l. From one to four different pesticides were detected in each well, and the pesticides detected in each well usually differed between sampling rounds. Total pesticide concentrations in each well ranged from 0.0005 to 0.0180 μg/l, with the highest total concentration occurring at MW-211D. In general, fewer pesticides were detected in July than in March/April, even though most of the pesticides detected in July were present in more wells than in March/April. Between the two sampling rounds, the pesticides identified most frequently include members of the DDT group, which was detected in all wells except OW-08, MW-211B, and those from the MW-210 cluster.

For each well or well cluster there were no consistent detections of individual pesticides between the sampling rounds. Most pesticides were generally reported in fewer than five wells between the two sampling rounds. Between the two sampling rounds, nine pesticides were detected in the shallow overburden wells. In March/April, seven pesticides were detected in the downgradient wells: heptachlor epoxide and aldrin in OW-03; endosulfan II and endosulfan sulfate in MW-211S; dieldrin and DDT in MW-212S; and methoxychlor in MW-210S. During the same round, methoxychlor was also found in the vicinity well, OW-08. In July, the three of the four pesticides identified were detected in three of the downgradient wells: endosulfan sulfate in OW-03; DDD in OW-03 and MW-211S; and DDE in OW-03, MW-211S, and MW-212S. The fourth pesticide, endosulfan II, was detected in the vicinity well, OW-08. No pesticides were detected in MW-210S in July. Of the pesticides detected, methoxychlor and DDD were not found in any of the deep overburden or bedrock wells.

A total of 10 pesticides were identified in the deep overburden wells during the two sampling rounds. In March/April, the six pesticides found include *gamma*-BHC and endosulfan II in MW-211D; dieldrin in MW-211D, MW-212D, and OW-02; heptachlor epoxide in MW-212D and OW-02; and endosulfan sulfate in MW-211D and OW-02. Aldrin and endosulfan sulfate were detected in the vicinity area well, OW-07, during March/April. In July, the only pesticides detected in downgradient wells were DDE in MW-211D, MW-212D, and OW-02 and *delta*-BHC in OW-02. In contrast, four pesticides were found in OW-07: DDE and DDT; endrin; and *delta*-BHC.

In the bedrock wells, six pesticides were detected. Endosulfan sulfate was found in MW-210B and endrin aldehyde was found in MW-212B. Heptachlor epoxide, *gamma*-chlordane, and *delta*-BHC were found in OW-01 during March/April. In July, *delta*-BHC was again detected in OW-01, endosulfan sulfate was detected in MW-211B, and DDE was detected in MW-212B and OW-01.

Of the 14 pesticides detected, over half were not detected in any of the associated upgradient wells. For the pesticides detected in upgradient and downgradient or vicinity wells, concentrations in the downgradient and vicinity wells were generally less than or near to concentrations detected in the upgradient wells. In addition, no pesticides were previously detected in the OW-01/02/03 or OW-07/08 clusters (CDM, 1987).

Two PCB Aroclors, 1232 and 1260, were detected in March/April and no PCBs were detected in July. Aroclor 1260 was found in eight samples from downgradient wells including all four of the shallow overburden wells (MW-210S, MW-211S, MW-212S, and OW-03), three deep overburden wells (MW-211D, MW-212D, and OW-02), and only one of the bedrock wells (OW-01). Concentrations ranged from 0.006 to 0.08 μg/l. Aroclor 1232 was found in only one of the vicinity wells, OW-07, at 0.05 μg/l. In comparison, no PCBs were detected in the associated upgradient wells or at OW-01/02/03 or OW-07/08 during the Phase 1A RI (CDM, 1987)

Basic cations were the dominant major metal ions detected in wells during both sampling rounds, and concentrations were similar between sampling rounds. A wide range of basic cation concentrations were exhibited by wells from each groundwater flow zone, but no discernable patterns are evident. For calcium, concentrations ranged from 10,400 to 96,600 μg/l. For magnesium, concentrations ranged from 1,540 to 16,500 μg/l. For sodium, concentrations ranged from 9,660 to 485,000 μg/l, with the highest concentration occurring at OW-07. For potassium, concentrations ranged from 1,920 to 22,300 μg/l. During both sampling rounds, the highest basic cation concentrations tended to occurred at MW-211S and MW-211D, in the shallow and deep overburden flow zones, respectively, and at MW-212B, in the bedrock flow zone. However, basic cation concentrations were near to or less than concentrations reported at the associated upgradient wells.

In comparison, the only well for which aluminum was reported was OW-07 (210 μg/l) in March/April. Although aluminum was detected in a few other wells during both sampling rounds, the detected concentrations were relatively low and the data were qualified as nondetected during validation (section 2.3.2). On the other hand, iron was readily detected in groundwater samples during both sampling rounds. Concentrations in downgradient wells were similar between sampling rounds and ranged from 117 to 82,000 μg/l, with the highest concentrations occurring in the shallow and deep overburden wells in the MW-21.1 cluster (58,500 to 82,000 μg/l). Iron concentrations in the vicinity wells were from 849 to 3,615 μg/l. In general, iron concentrations were higher in the downgradient and vicinity well clusters compared to the associated upgradient wells, and the mean concentration was found to be significantly higher than the mean concentration for background wells (Appendix I).

Like most major metal ions, barium and manganese were readily detected in the downgradient and vicinity well clusters, and concentrations were somewhat higher in March/April than in July. Barium concentrations of up to 60.7 μg/l were found in the three downgradient well clusters (MW-210, MW-212, and OW-01/02/03) and the vicinity area cluster (OW-07/08), while higher concentrations were detected in the MW-211 cluster (83.0 to 149 μg/l). Barium concentrations in these wells tended to be more elevated than concentrations detected in the associated upgradient wells, except for OW-25, the upgradient deep overburden well. Manganese concentrations ranged from 229 to 6,400 μg/l, although there were no apparent trends between wells or well clusters. The mean concentration for manganese was found to be statistically higher than the mean concentration for the background wells (Appendix I).

Ten other heavy metals were detected in wells over the two sampling rounds including arsenic, chromium, cobalt, copper, lead, nickel, selenium, thallium, vanadium, and zinc. These metals were detected more frequently in March/April than in July. Of the heavy metals detected, arsenic was the most prevalent, being detected in all of the wells except OW-01. More of these heavy metals were detected in the two overburden wells in the downgradient well cluster, MW-211, and the vicinity area deep overburden well, OW-07, than in other wells.

Six heavy metals were found in the shallow overburden wells. Well MW-211S typically exhibited the highest concentrations for individual metals. Arsenic, at concentrations of 5.5 to 186 μg/l, was detected in three wells in March/April (downgradient wells MW-210S and MW-211S and vicinity area well OW-08) and in all five shallow overburden wells in July. Arsenic was also reported at 14 μg/l in OW-03 during the Phase 1A RI (CDM, 1987). Cobalt was also detected in three wells (MW-210S, MW-211S, and OW-03) during March/April (3.1 to 6,6 μg/l), whereas in July it was only detected in two wells, MW-210S and MW-211S (3.0 to 6.1 μg/l). Other heavy metals detected in shallow overburden wells include lead (MW-210S and MW-211S), selenium (MW-211S and OW-08), and zinc (MW-210S) in March/April and vanadium (MW-211S, MW-212S, and OW-08) in July; these metals were found at concentrations of 1.0 to 8.8 μg/l. In comparison, only selenium and zinc were not detected in the upgradient shallow overburden wells.

For samples collected from deep overburden wells, all of the heavy metals detected in March/April occurred in one downgradient well, MW-211D, and the vicinity area well, OW-07. Arsenic, cobalt, and lead were found in both wells at concentrations of 8.1 and 345 μg/l, 2.3 and 12.2 μg/l, and 6.7 and 25.2 μg/l, respectively. Chromium, copper, and zinc were also detected in OW-07 (20.6 to 35.4 μg/l), while thallium was detected at 8.9 μg/l in MW-211D. In July, arsenic at concentrations of 7.2 to 278 μg/l was detected from all four of the deep overburden wells, with the highest concentration occurring at MW-211D. During the Phase 1A RI, arsenic was also found at 18 μg/l in OW-07. The two other heavy metals that were found in July consist of cobalt at 10.7 μg/l and vanadium at 2.7 μg/l, both of which were detected in MW-211D. Of all the heavy metals detected, chromium, copper, lead, and zinc were not found in the upgradient deep overburden well.

The only heavy metal detected during March/April in the bedrock wells was lead (3.1 μg/l) at MW-210B. The only heavy metal detected in July was arsenic from 2.8 to 11.9 μg/l in the three downgradient wells (MW-210B, MW-211B, and MW-212B). Of theses metals, only arsenic was found in the upgradient bedrock well.

During July, the three wells from the MW-212 cluster were sampled for WQPs. Alkalinity ranged from 51 to 106 mg/l $CaCO_3$, the highest value occurring in the bedrock well. In addition, hardness was calculated for all wells and ranged from 32 to 311 mg/l. Chloride concentrations ranged from 97 to 129 mg/l, SO_4 concentrations ranged from 11 to 31 mg/l, and total P concentrations ranged from 0.033 to 0.072 mg/l. Only the bedrock well had a detectable NO_3/NO_2 concentration (0.01 mg/l). Cyanide was not detected in any of the wells. While BOD was not detected in any of the wells, COD ranged from 9 to 12 mg/l. The TDS levels in all three wells (268 to 404 mg/l) were considerably higher than the TSS levels (0.9 to 2.3 mg/l). Similar levels of TOC (2.0 to 3.0 mg/l) were measured in all three wells.

Field parameters were measured during both sampling rounds and indicate that geochemical conditions were relatively consistent. Values for pH ranged from pH 5.5 to 7.7, which falls within the range of normal waters. Specific conductance values of up to 1,300 μmhos/cm were measured in March/April, while slightly lower values of up to 850 μmhos/cm, were measured in July. Redox potential ranged from -83 to 445 mV and DO values ranged from 0.06 to 15.2 mg/l. While turbidities at most wells were less than 5 NTU, turbidities of up to 25 NTU were measured in some wells in July. In addition, turbidities of 120 and 160 NTU were detected in July at MW-210S and MW-210B, respectively.

Summary of Findings. As discussed in section 4.2.1.3, wastes typical of municipal and commercial/industrial wastes were apparent during drilling activities, with the wastes being limited to the west-central portion of the landfill, as delineated in Figure 3-13. The predominant types of organic compounds detected in subsurface soil located within the waste area include aromatic VOCs, PAHs, petroleum hydrocarbons, long-chained alkanes, pesticides, PCBs, and phthalates. Heavy metals were also present at elevated concentrations in subsurface soil, and pesticides were prevalent in surface soil throughout the landfill.

Chlorinated and aromatic VOCs, pesticides, and two PCBs were found in groundwater downgradient and in the vicinity of the landfill, but individual compounds were not consistently detected between sampling rounds or between wells. For the majority of compounds detected, concentrations were near or below SQLs. No chlorinated VOCs were detected in groundwater from shallow overburden wells; however, 1,1- and 1,2-DCE, and vinyl chloride were found at several groundwater-screening locations. In particular, these chlorinated VOCs were found at elevated concentrations at two locations adjacent to the southern delineated edge of the waste area. All are typical landfill indicators, being either directly disposed of in the landfill or generated as degradation products of materials containing chlorinated chemicals. Furthermore, vinyl chloride typically exists as a gas under normal environmental conditions and its presence near the top of the water table suggests that there probably is substantial interaction between soil gas and groundwater occurring at this interface.

Chlorinated VOCs were detected in groundwater from the deep overburden and bedrock flow zone at two of the four downgradient well clusters, MW-212 and OW-01/02/03. The only chlorinated VOC found in a downgradient deep overburden well (1,1,2,2-PCA) occurred in July, whereas chlorinated VOCs (TCE and 1,2-DCA) were detected during both sampling rounds in the bedrock wells from both well clusters. Additionally, chlorobenzene (the only aromatic VOC found in a downgradient well) was detected in the shallow overburden well MW-210S and in the bedrock well OW-01 during March/April.

In comparison, aromatic VOCs (benzene and xylenes) were found in groundwater from the shallow overburden well, while the chlorinated VOCs (TCE and 1,2-DCE) were found in the deep overburden well from the vicinity well cluster (OW-07/08). The same compounds were detected both sampling rounds at similar concentrations in each of the respective wells. The concentrations detected for these VOCs were greater than the concentrations detected at the downgradient well clusters. The differences in the VOCs detected at the OW-07/08 cluster compared to wells directly downgradient of the landfill, coupled with the OW-07/08 cluster not being hydrogeologically downgradient of the landfill (section 3.2), suggests that another source, such as the Johns-Manville Asbestos Lagoons may be affecting groundwater quality in this area of the Site.

Fourteen pesticides were found in wells associated with this landfill. Between one and four pesticides were found in all wells during the two sampling rounds, but the individual pesticides detected at each well were not consistent between sampling rounds. No pesticide or group of pesticides was more prevalent than any other and no pattern of distribution was apparent.

Although PCBs were only detected in March/April, they were one of the most prevalent organic compounds found during that period, being identified in nine of thirteen wells. PCB Aroclor 1260, one of the more soluble Aroclors, was detected in eight of the wells.

The detection of chlorinated and aromatic VOCs, pesticides, and PCBs can indicate the possible presence of free or residual sources of product, either lighter or heavier than water. However, no product or sheens suggestive of free product were observed during purging or sampling of the wells or during the multiple rounds of water level measurements conducted at the wells. There was also no evidence of product or staining in subsurface material during the installation of wells or soil boring advanced during this RI.

All of the organic compounds detected in downgradient and vicinity well clusters are similar to those detected in subsurface soil located within the landfill; however, the RSI Landfill is not the only potential source of these organic compounds. All of the chlorinated VOCs detected in the downgradient and vicinity wells were also detected at similar concentrations in the upgradient bedrock well indicating that upgradient sources may also be affecting groundwater quality, particularly in the bedrock flow zone. At the same time, the Johns-Manville Asbestos Landfill may also be a potential source of the elevated benzene and xylene concentrations exhibited in the shallow overburden flow zone in vicinity well OW-08, since this well is more hydrogeologically affected by that landfill than by the RSI Landfill (section 3.3).

Historical data also suggest there has been little change in chemical quality of wells associated with this landfill. The same aromatic and chlorinated VOCs detected during the current two sampling rounds at the existing wells OW-01 and OW-07/08 were also detected at similar concentrations in 1986 during the Phase 1A RI (CDM, 1987). Because of the irregular occurrence of the organic compounds between sampling rounds and well clusters, no specific plume was delineated for VOCs or other organic compounds.

As would be expected based on the geochemical composition of soils and geologic formations, basic cations, iron, barium, and manganese were the most prevalent metals detected in groundwater. It is assumed that these metals were largely present in dissolved phases as there were few solids present during sampling, given the low turbidities and TSS values coupled with the high TDS values. Except for iron, concentrations of these metals were close to or less than those detected in the associated upgradient wells.

Over the two sampling rounds, 10 other heavy metals were detected and these were more frequently detected in March/April than in July. Of the heavy metals detected, all but selenium and zinc were found in the upgradient wells. Groundwater from the MW-211 cluster exhibited a greater number of heavy metals and the highest concentrations for many of the metals. Note, that the elevated chromium and copper concentrations observed in subsurface soil at this landfill was not evident in groundwaters.

The WQP data and field parameter data did not identify any anomalies suggesting that the geochemical conditions of groundwater in wells associated with the landfill were outside of ranges typically exhibited in most natural systems. With the exception of somewhat higher turbidity readings at a few wells in July, these data indicate that groundwater conditions did not substantially differ between sampling rounds.

4.2.2.4 B&M Locomotive Shop Disposal Areas. Groundwater samples were collected from a total of eleven wells in four well clusters associated with Locomotive Shop Disposal Areas A and B (Table 4-10): upgradient wells (MW-204 cluster), downgradient wells (MW-205 and MW-206 clusters), and wells in the vicinity (OW-39/40 cluster). The MW-205 cluster is considered to be downgradient of Area B, while the MW-206 cluster is considered to be downgradient of Area A. No wells are located directly in the source area, which is considered to be the two disposal areas.

Groundwater samples were collected from all of the wells associated with the B&M Locomotive Shop Disposal Areas during both sampling rounds. The analytes detected in groundwater during the March/April and July sampling rounds are summarized in Tables 4-18 and 4-19, respectively. The predominant types of organic compounds and metals detected during both sampling rounds are presented for shallow and deep overburden and bedrock wells in Figures 4-27 through 4-32.

Upgradient Wells. Several organic compounds were detected in the upgradient wells including a few VOCs and pesticides and one PCB Aroclor. Neither SVOCs nor petroleum hydrocarbons were found during either sampling round.

No VOCs were detected in the shallow overburden well (MW-204S) in March/April, but two VOCs were detected in July (1,1,2,2-PCA at 3 μg/l and MIBK at 16 μg/l). In the deep overburden well, MW-204D, the only VOC found was toluene at 9 μg/l in March/April and at 4 μg/l in July. Volatile organic compounds were not detected in the bedrock well, MW-204B, during either sampling round.

Pesticides were detected in the shallow and deep overburden wells at relatively low concentrations (0.001 to 0.004 μg/l). Heptachlor epoxide, endosulfan I, and endosulfan II were identified in the shallow overburden well in March/April, whereas *delta*-BHC was identified in July. In July, endosulfan sulfate was detected in the deep overburden well. Pesticides were not detected in the bedrock well during either sampling round. The only PCB that was detected in an upgradient well during either sampling round was Aroclor 1260 at 0.01 μg/l in the bedrock well in July.

Major metal ions concentrations in the wells were similar between sampling rounds, but no consistent trends between groundwater flow zones were apparent. Aluminum was detected at relatively low concentrations but was qualified as nondetected during validation (section 2.3.2) in all but the deep overburden well, where it was detected at 841 μg/l. Like aluminum, many iron results were qualified as nondetected; the detected concentrations ranged from 74.4 to 3,890 μg/l. Calcium concentrations ranged from 7,530 to 38,900 μg/l, magnesium concentrations ranged from 137 to 8,270 μg/l, sodium concentrations ranged from 10,800 to 22,300 μg/l, and potassium concentrations ranged from 1,610 to 3,390 μg/l.

Barium, manganese, and seven heavy metals were also detected in the upgradient wells. Barium and manganese were detected during both sampling rounds in most of the upgradient wells at concentrations ranging from 5.9 to 37.2 μg/l and 64.0 to 11,000 μg/l, respectively. In the shallow overburden well, cobalt was found at 16.8 and 53.3 μg/l in March/April and July, respectively, zinc was found at 15.1μg/l in March/April and nickel was found at 14.7 μg/l in July. In the deep overburden well arsenic was detected at 11.8 μg/l in March/April and at 16.6 μg/l in July. Vanadium was also detected in the deep overburden well during both sampling rounds, at 23.7 μg/l in March/April and at 24.3 μg/l in July. In addition, zinc was detected in March/April at 4.8 μg/l and chromium was detected in July at 1.0 μg/l in the deep overburden well. The only heavy metals detected in the bedrock well were lead at 2.4 μg/l in March/April and arsenic at 5.1 μg/l in July. Except for cobalt and nickel, all of these metals were also detected in at least one of the background wells. The concentrations detected in the upgradient wells were less than or near to the concentrations found in the background wells.

Cyanide was not detected in any of the upgradient wells during either the March/April or the July sampling rounds. None of the upgradients wells were analyzed for other WQPs. However, hardness values were calculated and ranged from 7 to 228 mg/l.

Field parameters, measured during both sampling rounds, indicate that slightly acidic conditions exist in the groundwater at the shallow overburden well (pH values of 5.6 and 4.7), with more neutral conditions in the bedrock well (pH values of 7.6 and 7.1). It is not known why pH values measured in the deep overburden well (11 and 9.8) were so much higher than those measured at the shallow overburden and bedrock wells. There is no indication that bentonite was drawn into the well during sampling based on basic cation concentrations, specific conductance readings, or turbidity readings. In fact, specific conductances, which ranged from 99 to 470 μmhos/cm, were highest in the shallow overburden well and decreased in the deep overburden and bedrock wells during both sampling rounds. Turbidity values greater than zero were noted only during March/April in the shallow and deep overburden wells (16 and 9 NTU, respectively). Redox potential varied between wells and between sampling rounds, ranging from -255 to 278 mV. Dissolved oxygen values up to 9.8 mg/l were measured.

Downgradient and Vicinity Wells. The only VOC detected in downgradient and vicinity wells was 1,2-DCA (3 μg/l) at OW-40 in July. However, chlorinated VOCs were detected at two groundwater screening locations in 1993: 1,2-DCE at 22 μg/l and vinyl chloride at 12 μg/l in CW-22 (Area A) and 1,1-DCE at 1.3 μg/l in CW-27 (Area B).

No SVOCs were detected in any of the wells during either sampling round; however, petroleum hydrocarbons were detected at 1.4 mg/l in MW-206D in March/April only. In all, six pesticides were detected at concentrations ranging from 0.0004 to 0.002 μg/l. Chlordanes were identified in the shallow overburden well (MW-205) downgradient of Area B; *alpha*-chlordane was found in March/April and *gamma*-chlordane was found in July. The only pesticides detected in the deep overburden wells were DDT in March/April and endosulfan I in July, both occurring in the vicinity well, OW-39. Two pesticides (heptachlor epoxide and endosulfan sulfate) were also detected in the bedrock well, MW-206B. Both pesticides were detected in March/April, whereas no pesticides were detected in July. In addition, PCB Aroclor 1260 was detected in March/April at less than 0.01 μg/l in three downgradient wells (MW-206S, MW-206D, and MW-205B). It should also be noted that no organic compounds were detected in OW-39 or OW-40 during the Phase 1A RI (CDM, 1987).

As with the upgradient wells, most of the aluminum and iron data from these wells were qualified as nondetected during validation (section 2.3.2). As a result, no aluminum concentrations are reported, while the few iron concentrations that were detected were as high as 2,500 μg/l. Basic cations were detected in all wells and concentrations ranged from 7,640 to 152,000 μg/l for calcium; 1,050 to 30,100 μg/l for magnesium; 3,140 to 176,000 μg/l for sodium; and 771 to 9,970 μg/l for potassium. The highest concentrations occurred in samples from the MW-205 and MW-206 clusters.

In addition to major metal ions, barium, manganese, and seven other heavy metals were detected. Barium was found from 1.4 to 77 μg/l in all of the wells in March/April, but was found in only one well from each groundwater flow zone during July (23.7 to 100 μg/l). Manganese was found in almost all of the wells during both sampling rounds, at concentrations of 4.8 to 1,140 μg/l. In general, more heavy metals were detected in wells from the downgradient clusters MW-205 and MW-206 than in wells from the vicinity cluster OW-39/40. The other heavy metals detected in the shallow overburden during March/April include cobalt and copper from 2.5 to 8.7 μg/l in MW-205S and MW-206S, lead at 3.8 μg/l in MW-205S, and zinc at 18.9 and 114 μg/l in MW-205S and OW-40, respectively. Of these metals, cobalt at 3.1 μg/l in MW-206S and zinc at 136 μg/l in OW-40 were also detected in July. Also detected in July were arsenic at 4.3 μg/l in MW-205S and nickel at 2.8 and 7.3 μg/l in MW-206S and OW-40, respectively.

In the deep overburden, more heavy metals were detected in March/April than in July. In March/April, cobalt, copper, and zinc were detected from 3.2 to 31.1 μg/l in MW-205D and MW-206D, while lead at 4.7 μg/l and mercury at 0.53 μg/l were only detected in MW-206D and nickel at 18.3 μg/l was only detected in MW-205D. Zinc at 4.1 μg/l was also found at OW-39 in March/April. The only metals found in deep overburden wells in July consist of cobalt (0.86 μg/l) and nickel (3.4 μg/l) in MW-206D and nickel (4.6 μg/l) and zinc (261 μg/l) in MW-205D.

In contrast more heavy metals were found in the bedrock wells in March/April compared to July and all of the heavy metals were detected only in MW-206B. The metals detected at MW-206B in March/April include copper at 5.1 μg/l and zinc at 6.4 μg/l and the metals detected in July include cobalt, copper, lead, and nickel from 1.9 to 4.4 μg/l.

All of the heavy metals detected in downgradient and vicinity wells, except for mercury and copper, were also detected in at least one of the upgradient wells. And in most cases, concentrations of individual heavy metals in downgradient and vicinity wells were generally less than concentrations in the upgradient wells. No heavy metals, with the exception of manganese, have been previously reported in either well from the OW-39/40 cluster (CDM, 1987).

Cyanide was not detected in any of the wells during either of the sampling rounds. All wells from the MW-205 cluster in March/April and MW-206D in July were analyzed for other WQPs. Alkalinities in these wells ranged from 42 to 446 mg/l $CaCO_3$, with values decreasing from the shallow overburden to the bedrock wells. Hardness values from 31 to 503 mg/l were calculated. Chloride concentrations ranged from 5.9 to 88.4 mg/l, NO_3/NO_2 concentrations ranged from 0.02 to 3.30 mg/l, SO_4 concentrations ranged from 7 to 96 mg/l, and total P concentrations ranged from 0.016 to 0.20 mg/l. While BOD was not detected, CODs of 6 to 18 mg/l were found in the shallow and deep overburden wells. Total dissolved solid levels (57 to 624 mg/l) were considerably higher than TSS levels (0.1 to 6.3 mg/l). Total organic carbon values ranging from 1.0 to 8.5 mg/l were measured in the shallow and deep overburden wells.

Field parameter measurements indicate that field-measured geochemical conditions were relatively consistent between the two sampling rounds. A narrow range of pH values (4.8 to 7.0) were measured, along with a wide range of specific conductances (86 to 1,600 μg/l). Redox potentials of 24 to 608 mV were recorded. Dissolved oxygen levels ranged from 0.2 to 14 mg/l. Turbidities ranged from 0 to 19 NTU in March/April, but were more elevated in July (0 to 100 NTU).

Summary of Findings. As discussed in section 4.2.1.4 previous disposal activities have contributed to mounded areas of wastes in the two B&M Locomotive Shop Disposal Areas (A and B). The areas are characterized by fill intermixed with wastes including wood, ash, metal, plastic, and asphalt. The most common types of organic compounds detected in surface and subsurface soil were pesticides, PAHs, and petroleum hydrocarbons, the latter two being indicative of fuel/petroleum-related products. Elevated concentrations of heavy metals, particularly copper and lead, were noted in the soil.

One volatile organic, a few pesticides, and a PCB Aroclor were the only organic compounds detected in groundwater from downgradient and vicinity wells. The only chlorinated VOC detected was 1,2-DCA in the shallow overburden flow zone of a vicinity well. That this chlorinated VOC is related to the two disposal areas is unlikely, since VOCs were not detected in subsurface soil and the vicinity well cluster is not considered to be directly affected by the disposal areas. Furthermore, a few VOCs (including chlorinated compounds) were detected in the shallow and deep overburden flow zones of the upgradient cluster, indicating that sources other than the two disposal areas may also be present in the immediate vicinity. However, the detection of organic vapors measured during drilling activities at PZ-106B indicates the potential for the existence of VOCs in soil gas above the water table.

The pattern in which pesticides were detected is similar to that observed at the other areas of concern. Pesticide concentrations were relatively low and different pesticides were detected in wells within the same cluster and within the same groundwater flow zone. In addition, pesticides detected in individual wells differed between sampling rounds. The same types of pesticides detected in groundwater (chlordanes, DDT, and endosulfans) were also detected in soil from the two disposal areas. For this reason, it is possible that soil from the two disposal areas is the source of pesticides in groundwater, particularly at downgradient wells; however, the relatively low concentrations are consistent with the limited mobility of pesticides in groundwater because of their low solubility and tendency to strongly adhere to soil particulate material. It is likely that the pesticides may be adsorbed to the limited quantity of solids that were measured in the well (based on TSS and turbidity measurements).

The detection of PCB Aroclor 1260 in samples from downgradient wells in all three flow zones during March/April probably results from mechanisms similar to those for pesticides. Although Aroclor 1260 was not detected in any of the soil samples collected from the two disposal areas, Aroclors 1242 and 1254 were found at a depth of 10 to 12 feet at one boring advanced in the central portion of Area B. Given the likelihood that different wastes were unevenly disposed of over a period time, it is possible that different PCB Aroclors may be present elsewhere in Area B.

More heavy metals were detected at the downgradient well clusters than at the vicinity well cluster. Of the seven additional heavy metals that were detected in groundwater from the downgradient and vicinity wells, all but mercury and copper were found in the upgradient wells. And for the heavy metals that were also detected in the upgradient wells, concentrations were generally lower. The same heavy metals were also detected in soil from the disposal areas.

4.2.2.5 Old B&M Oil/Sludge Recycling Area. Groundwater samples were collected from a total of 17 monitoring wells in 6 well clusters associated with this area (Table 4-10): upgradient wells (MW-201 cluster), source area wells (OW-41/42/43 cluster), downgradient wells (MW-202, MW-203, and OW-37/38 clusters), and vicinity wells (OW-17/18/19 cluster).

Groundwater samples were obtained during both sampling rounds from all of the wells associated with this area. The analytes detected in the March/April and July sampling rounds are summarized in Tables 4-20 and 4-21, respectively. The predominant types of organic compounds and metals detected are presented for shallow and deep overburden and bedrock wells in Figures 4-27 through 4-32.

Upgradient Wells. Five organic compounds, consisting of two VOCs and three pesticides, were detected in the upgradient wells. The organic compounds were detected in the shallow overburden and bedrock wells, and none were detected in the deep overburden well. Most concentrations were below SQLs, and most compounds were not detected consistently over the two sampling rounds. No SVOCs, PCBs, or petroleum hydrocarbons were found.

1,1,1-Trichloroethane was found during both sampling rounds at similar concentrations in the shallow overburden well (7 $\mu g/l$ in March/April and 12 $\mu g/l$ in July). Carbon disulfide was detected at 5 $\mu g/l$ in the bedrock well in March/April. Carbon disulfide was also detected in a background bedrock well at a similar concentration (7 $\mu g/l$).

The three pesticides that were detected include DDT and endosulfan sulfate in the shallow overburden well in July and heptachlor epoxide in the bedrock well during March/April. Individual concentrations ranged from 0.001 to 0.002 μg/l. It should be noted that the pesticides detected in the shallow overburden well were not detected in the field duplicate collected at this well.

Basic cations were detected at concentrations ranging from 12,200 to 58,600 μg/l for calcium, 1,070 to 9,640 μg/l for magnesium, 3,590 to 23,900 μg/l for sodium, and 1,430 to 5,560 μg/l for potassium. The highest concentrations were generally found at the shallow overburden well in July, primarily as a result of elevated concentrations in the field duplicate sample collected at this well. For the most part, basic cation concentrations were similar between the other wells and between sampling rounds. On the other hand, iron concentrations varied widely between wells and between sampling rounds, ranging from 22.0 to 17,700 μg/l.

Barium was detected in the shallow overburden and bedrock wells, but not in the deep overburden well. Barium concentrations ranged from 11.8 to 39.1 μg/l. Manganese was detected during both sampling rounds in all of the wells from the upgradient well cluster. Manganese was found at 249 and 760 μg/l in the shallow overburden well, at 10.2 and 10.8 μg/l in the deep overburden well, and at 48.0 and 1,170 μg/l in the bedrock well during March/April and July, respectively. Seven other heavy metals found in wells during one or both sampling rounds were generally detected in only one sample each round. In March/April, vanadium (2.1 μg/l) was detected in the bedrock well and zinc (104 μg/l) was detected in the shallow overburden well. Arsenic was detected in all of the upgradient wells in July, at concentrations that ranged from 4.7 to 13.1 μg/l. Cobalt was detected in the shallow overburden and bedrock wells at 4.7 and 8.1 μg/l, respectively. The remaining four heavy metals were detected only in the shallow overburden well: cadmium at 0.55 μg/l, copper at 15.3 μg/l, lead at 2.3 μg/l, and nickel at 5.4 μg/l. Most of these metals were only present in the field duplicate sample collected from the shallow overburden well in July. It is possible that the obvious differences between the metals data for the field duplicate sample and the associated sample collected in July, as well as the sample collected in March/April, may be caused by the presence of small amounts of solids or other particulates in the field duplicate sample. Therefore, the elevated metal concentrations shown for the shallow overburden sample in July might be higher than expected under similar conditions.

With the exception of the shallow overburden well in July, basic cations and other metals detected in the upgradient wells were usually within the concentration ranges found in the background wells. The only exception was the higher iron concentrations in the upgradient wells.

Cyanide and hardness data are the only WQPs available for these wells. Cyanide was not detected during either round in any of the well. Calculated hardness values typically ranged from 12 to 55 mg/l, although the value for the shallow overburden well was higher (306 mg/l) in July.

Values of pH were higher during both sampling rounds in the deep overburden and bedrock wells (8.0 to 9.2) compared to the shallow overburden well (6.3). Specific conductance generally ranged from 130 to 190 μmhos/cm, but were higher in the shallow overburden well in July (300 μmhos/cm). The higher specific conductance at this well coincides with elevated metal concentrations that occurred during the same period. During both sampling rounds, Eh values were similar in the shallow overburden and bedrock wells (88 to 179 mV) compared to the deep overburden well (-30 and -7.4 mV). Dissolved oxygen ranged from 0.7 mg/l to 5.6 mg/l and turbidity readings were less than 10 NTU.

Source, Downgradient, and Vicinity Wells. Over the two sampling rounds, at least one compound was detected in 5 of the 14 samples collected from wells located in the source, downgradient, and vicinity of this area. The four wells where organic compounds were not measured during either sampling round consists of one shallow overburden well (OW-42), one deep overburden well (OW-41), and two bedrock wells (OW-17 and MW-202B). Overall, organic compounds were found in at least one of the wells at each well cluster.

Four VOCs were detected during the two sampling rounds. The only VOC found in shallow overburden wells was chlorobenzene (3 μg/l) during March/April at MW-202S, a downgradient well. In the deep overburden wells, 1,1,1-TCA and 1,1-DCA were detected both sampling rounds (3 to 6 μg/l) in MW-203D, which is also a downgradient well. The 1,1,1-TCA concentrations that were detected were lower than those measured for this compound in the upgradient wells. In addition, chloroform was detected in bedrock well MW-203B in March/April, and 1,1-DCA was detected during both sampling rounds (3 and 4 μg/l) in bedrock well OW-37, another downgradient well. Chlorinated VOCs have also been detected in wells in this area during the Phase 1A RI. As reported by CDM (1987), 1,1-DCE (2μg/l) and 1,1-DCA (4 μg/l) were found in the deep overburden well, OW-41, while 1,1-DCA (3 μg/l) was found in the deep overburden well from the OW-37/38 cluster.

1,1-Dichloroethene was detected at 4 of the 10 groundwater-screening locations associated with this area (Figure 4-25). Concentrations at four screening locations (GW-11, GW-17, GW-18, and GW-20), all of which are near the downgradient boundaries of the northern and southern source areas, ranged from 2.3 to 12 μg/l. In addition, vinyl chloride was also detected at two of the screening locations, GW-18 and GW-20, at concentrations of 11.2 and 30 μg/l. Furthermore, VOCs were not measured at the two screening locations within the two delineated source areas, GW-14 and GW-15.

The only SVOC detected was bis(2-ethylhexyl)phthalate, in the shallow overburden groundwater flow zone in July, at MW-202S (3 μg/l) and at OW-19 (5 μg/l), a vicinity area well. Since bis(2-ethylhexyl)phthalate is a common laboratory contaminant, and the concentrations detected are below the SQLs, it is likely that the concentration is a laboratory artifact.

Ten pesticides were detected in the wells over the two sampling rounds. Generally, different pesticides were detected during each sampling round. Members of the DDT group were the most frequently detected pesticides, with DDD found in four wells in March/April and DDE found in four wells in July. One to three pesticides were detected in wells during the two sampling rounds. Individual and total concentrations ranged from 0.0003 to 0.008 μg/l.

Pesticides were identified in samples from two shallow overburden wells in March/April: DDD at MW-202S and DDD and dieldrin at OW-19. No pesticides were detected in these wells in July. Instead, different pesticides were detected in two other wells: MW-203S (*delta*-BHC, *gamma*-chlordane, and DDE) and OW-43 (*alpha*-BHC, and DDE). Well OW-43 is located within the source area, while MW-202S and MW-203S are downgradient of the source area and OW-19 is a vicinity area well.

Pesticides detected in deep overburden wells in March/April include endrin aldehyde at MW-202D; endosulfan sulfate at MW-203D; and DDD and heptachlor epoxide at OW-18. In July, the pesticides detected in the deep overburden wells consisted of DDE and endrin at MW-203D; DDE at OW-18; and *delta*-BHC at OW-38. The only pesticide detected in the bedrock wells was DDD at OW-37 in March/April.

With the exception of heptachlor epoxide and endosulfan sulfate, none of the pesticides detected in samples from these well clusters were found in upgradient wells. One other pesticide (DDT) which was detected in the upgradient wells was not found in these wells; however, other members of the DDT group (DDD and DDE) were present. No pesticides were previously reported by CDM (1987) in any of the existing well clusters (OW-17/18/19, OW-37/38, and OW-41/42/43)

PCB Aroclor 1260 was detected in three shallow overburden wells in March/April only: downgradient wells MW-202S and MW-203S and a vicinity well, OW-19; concentrations ranged from 0.01 to 0.02 μg/l. It should, however, be noted that no PCBs were detected in the field duplicate sample from OW-19. Petroleum hydrocarbons were detected in only one well. Petroleum hydrocarbons were detected at 2.5 mg/l in MW-202D during March/April.

Iron and basic cations were the dominant major metal ions detected in the wells. Concentration variations were noted between some wells over the two sampling rounds, but for most wells concentrations were relatively similar. Over the two sampling rounds, concentrations ranged from 10.2 to 23,500 μg/l for iron, from 7,840 to 120,000 μg/l for calcium, from 1,480 to 23,100 μg/l for magnesium, and from 2,440 to 134,000 for sodium, and from 1,090 to 16,700 μg/l for potassium. Aluminum, which was only reported in MW-202B at 649 μg/l in July, was also reported in several other wells. However, concentrations were lower than the concentration reported in MW-202B and were qualified as nondetected during validation (section 2.3.2). There were no apparent consistent trends between shallow and deep overburden and bedrock wells for iron or basic cations concentrations.

Barium, manganese, and nine heavy metals were also detected. Barium and manganese were readily detected in all wells except OW-18 and OW-19 during both sampling rounds. No major differences in concentrations were noted between the two sampling rounds. Barium concentrations ranged from 9.8 to 122 μg/l and manganese concentrations ranged from 21.3 to 1,480 μg/l. In comparison to upgradient wells, many of the barium and manganese concentrations detected in these wells were higher, but were not statistically different (Appendix I).

In contrast, the nine heavy metals were not consistently detected in specific wells or between sampling rounds. The heavy metals that were detected in shallow overburden wells during March/April include cobalt (14.7 μg/l), lead (3.3 μg/l), and mercury (0.37 μg/l) in OW-42, OW-43, and MW-203S, respectively. Of these metals, only cobalt (at 3.9 and 4.3 μg/l in MW-203S and OW-19, respectively) was detected in July. Other heavy metals that were detected in the shallow overburden wells in July include arsenic at concentrations from 9.9 to 27.1 μg/l in OW-19, MW-203S, and OW-42; vanadium at 1.5 μg/l in MW-202S; and nickel and zinc at 5.0 and 288 μg/l, respectively, in OW-43. Of all of the heavy metals detected in the shallow overburden wells, only mercury and zinc were not detected in the upgradient shallow overburden well.

During March/April, mercury at 0.2 μg/l in MW-203D and OW-41 was the only heavy metal detected in the deep overburden wells. In July, chromium at 4.7 μg/l was detected in OW-41, while nickel at 3.9 μg/l and vanadium at 0.59 μg/l were detected in MW-202D. None of these metals were detected in the upgradient deep overburden well.

Heavy metals were detected in only one bedrock well in March/April. Cobalt at 4.6 μg/l, copper at 42.2 μg/l, lead at 7.3 μg/l, and zinc at 30.4 μg/l were all detected in OW-37. In comparison, more heavy metals were detected in more bedrock wells during July. Arsenic, cobalt, and nickel were detected in OW-37 at concentrations ranging from 2.5 to 5.6 μg/l. Copper at 60.9 μg/l and arsenic, lead, and nickel from 2.8 to 9.6 μg/l were detected in MW-203B. Nickel at 112 μg/l was the only heavy metal found in OW-17, while vanadium at 1.1 μg/l and zinc at 44.9 μg/l were found in MW-202B. Of these metals only cobalt and vanadium were detected in the upgradient bedrock well. During the Phase 1A RI (CDM, 1987), arsenic was also detected in some of the existing wells.

During the March/April sampling round, wells from two clusters (OW-37/38 and MW-203 clusters) were analyzed for WQPs. Samples from two of these wells (MW-202B and MW-202D) were also analyzed for WQPs in July. Alkalinities, which ranged from 24 to 82 mg/l $CaCO_3$, were similar between wells and sampling rounds. There was a larger range between wells for hardness values that were calculated (17 to 392 mg/l), but there was little difference in values for wells between sampling rounds, except at OW-37 where the July value was three times higher than the March/April value. Chloride concentrations ranged from 3.4 to 67.8 mg/l, with the exception of OW-37 (560 mg/l). Concentrations of up to 44 mg/l for SO_4, 0.39 mg/l for NO_3, and 1.4 mg/l for total P were measured. Cyanide was not detected in any of the wells during either sampling round. No BOD was detected, but CODs of up to 29 mg/l were measured in samples collected during March/April. Values for TDS (64 to 1,060 mg/l) were elevated in comparison to TSS (0.7 to 17 mg/l). Total organic carbon values ranged from 0.8 to 4.6 mg/l.

Field parameters were measured at all wells during both sampling rounds. Values of pH ranged from 4.0 to 8.1, with values being somewhat higher in March/April compared to July. In the shallow and deep overburden wells, specific conductances of 76 to 360 μmhos/cm, whereas higher specific conductances of 130 to 2,000 μmhos were measured in samples from bedrock wells. Dissolved oxygen levels (up to 15 mg/l) varied between wells, and to a lesser extent, between sampling rounds. Considerable variations in Eh (-220 to 262 mV) were noted. For most wells turbidities less than 5 NTU were measured, but turbidities up to 20 NTU were noted for several wells and 110 NTU was measured at MW-202S in July.

Summary of Findings. Two areas of oil/sludge waste, located at the northern and southern edges of the fenced-in area, were delineated by M&E with geophysical, boring, and test pit data. The predominant types of organic compounds found in those areas were consistent with the oil/sludge disposed of at this area of concern and include aromatic VOCs, PAHs, long-chain alkanes, and petroleum hydrocarbons. Numerous pesticides and PCB Aroclor 1260 were also detected in the northern area. In addition, several heavy metals were detected at elevated concentrations (most notably lead, arsenic, chromium, copper, vanadium, and zinc) in both areas.

The aromatic VOCs, PAHs, and petroleum hydrocarbons found in subsurface soils in the source area were not present in the groundwater (in either wells or groundwater-screening locations). Instead, chlorinated VOCs were found in a few wells downgradient of the two oil/sludge waste areas. The source of these organic compounds is not known as they were not detected in subsurface soil, although this was a recycling area where maintenance types of wastes, including solvents, may have been disposed. However, there was no evidence of subsurface sources of chlorinated VOCs, nor any discernable VOC plumes.

Groundwater from OW-41/42/43, a source area well cluster, contained several heavy metals including arsenic, chromium, cobalt, lead, mercury, nickel, and zinc.

It should also be noted that there was no visual observation of free product or heavily-stained soils during well sampling or drilling activities, respectively. If a thin (e.g. several inches thick) floating layer was present, it may have went undetected because the tops of all of the well screens for the shallow overburden wells were usually one foot or more below the top of the water table. However, petroleum hydrocarbons were measured in one well (MW-202D) and 1 to 3 inches of floating product has been noted in a nearby piezometer (P-12) during several rounds of water-level measurements.

Like soils, numerous pesticides were found in the groundwater in the source area, downgradient, and vicinity area wells. The low frequency and inconsistency of detection of individual pesticides suggests that these disposal areas are not a specific source of pesticides. Rather, it is more likely that widespread use of pesticides has resulted in residuals occurring in subsurface soils, that are periodically present in groundwater, at relatively low concentrations that are adsorbed to particulate matter. This is probably a similar situation for the PCB Aroclor detected in three of the shallow overburden wells in March/April.

In many wells, barium and manganese were detected at higher concentrations than found in the upgradient wells; however, the mean concentrations were not statistically higher than the mean concentrations in the background wells (Appendix I). More heavy metals were detected in shallow overburden wells than in deep overburden and bedrock wells. The heavy metals detected include arsenic, chromium, cobalt, copper, lead, mercury, nickel, vanadium, and zinc.

4.2.2.6 Asbestos Lagoons. Groundwater samples were collected from a total of 12 monitoring wells in four well clusters associated with the Asbestos Lagoons (Table 4-10): upgradient wells (MW-208 cluster), downgradient wells (OW-9/10/11/12 and MW-209B/OW-20/21 clusters), and wells in the vicinity (OW-13/14 cluster). No wells are located directly in the source area of the Asbestos Lagoons.

Groundwater samples were obtained during both sampling rounds from all of the wells associated with the lagoons. The analytes detected in the March/April and July sampling rounds are summarized in Table 4-22 and 4-23, respectively. The predominant types of organic compounds and metals detected during both sampling rounds are presented for shallow and deep overburden and bedrock wells in Figures 4-27 through 4-32.

Upgradient Wells. Volatile organics were not detected in the shallow overburden well, MW-208S, during either sampling round, while 1,1-DCA was detected at 2 μg/l in the deep overburden well, MW-208B, in March/April and 1,2-DCA was detected at 4 and 3 μg/l during both sampling rounds in the bedrock well, MW-208B. One SVOC, bis(2-ethylhexyl)phthalate, was detected in March/April at 13 and 17 μg/l in the deep overburden and bedrock wells, respectively. One pesticide (dieldrin) was found in the shallow overburden well during March/April. A few pesticides were also detected in the deep overburden well: heptachlor epoxide and dieldrin in March/April and *delta*-BHC in July. The detected pesticide concentrations ranged from 0.0003 to 0.002 μg/l. In addition, PCB Aroclor 1254 was identified in March/April at 0.008 μg/l in the deep overburden well. No petroleum hydrocarbons were found in any of the upgradient wells during either sampling round.

Iron and basic cations were detected in the upgradient wells during both sampling rounds. As discussed in section 2.3.2, aluminum was also reported but was qualified as nondetected during validation. Although concentrations were similar between sampling rounds at each of the wells, differences were noted between the wells. Concentrations for these metals were higher in the deep overburden and bedrock wells except for iron, which was higher in the shallow overburden well. Iron concentrations in the shallow overburden well for March/April and July were 17,600 and 16,700 μg/l, respectively, compared to 79.1 and 88.4 μg/l and 753 and 517 μg/l for the deep overburden and bedrock wells, respectively. Calcium concentrations from 7,330 to 53,100 μg/l, magnesium concentrations from 1,410 to 10,800 μg/l, sodium concentrations from 12,600 to 36,800 μg/l, and potassium concentrations from 1,940 to 5,630 μg/l were reported, with the highest concentrations generally found in the bedrock well.

Barium, manganese, and five other heavy metals were detected in the upgradient wells. Barium and manganese were the most readily detected, with concentrations ranging from 34.7 to 61.2 μg/l and from 453 to 1,730 μg/l, respectively, which are higher than concentrations found in the corresponding background wells. In March/April, arsenic and cobalt were detected at 58.1 and 3.5 μg/l in the shallow overburden wells. Arsenic and cobalt were also detected in July at similar concentrations (49.6 and 3.9 μg/l, respectively) in the shallow overburden well. Cobalt was found in July at 0.70 μg/l in the deep overburden well and at 0.60 μg/l in the bedrock well. In addition, lead was detected in all three wells (1.6 to 3.0 μg/l) in July. Two more heavy metals were also detected in July: silver at 0.63 μg/l in the bedrock well and vanadium at 1.2 μg/l in the shallow overburden well. With the exception of cobalt and silver, each of these additional heavy metals were also detected in at least the deep overburden background well. In comparison, concentrations in the upgradient wells tended to be more elevated than concentrations in the background wells.

Cyanide was not detected in any of the upgradient wells during either the March/April or the July sampling rounds. Upgradient wells were also analyzed for other WQPs in July. Alkalinities ranged from 64 to 83 mg/l $CaCO_3$, and hardness values of 25 to 211 mg/l were calculated. Chloride concentrations in the deep overburden and bedrock wells (80.9 and 85.4 mg/l, respectively) were higher than the concentrations found in the shallow overburden well (13.9 mg/l). In the deep overburden and bedrock wells, NO_3/NO_2 was measured at 0.01 mg/l and SO_4 was measured at 23 and 25 mg/l, respectively. Total P ranged from 0.032 to 0.057 mg/l. A BOD value of 2.1 mg/l was measured in the shallow overburden well, and COD values for all wells ranged from 12 to 21 mg/l. Total organic carbon was measured at 4.9 mg/l in the shallow overburden well and at 2.4 mg/l in the deep overburden well. A range of 93 to 368 mg/l was detected for TDS compared with a range of 0.5 to 1.3 mg/l for TSS.

Field parameters measured during both sampling rounds indicate that field-measured geochemical conditions were relatively consistent between March/April and July. Values of pH (6.0 to 7.1) were within ranges typically found in groundwater in the northeast. Specific conductance measurements were higher in the deep overburden and bedrock wells (320 to 400 μmhos/cm) compared to the shallow overburden well (170 and 180 μmhos/cm). Dissolved oxygen concentrations were lower in March/April (1.1 to 2.6 mg/l) compared to July (12 to 14 mg/l). Values of Eh varied widely between wells and between sampling rounds, ranging from -70 to 111 mV. Turbidity readings of 0 to 4 NTU in March/April were low relative to readings of 83 to 120 NTU in July.

Downgradient and Vicinity Wells. Four VOCs, consisting of MIBK and three chlorinated VOCs, were detected during the two sampling rounds. At least one VOC was found in one or more wells from each cluster. Volatile organic compounds were only detected in two of the downgradient shallow overburden wells (OW-11 and OW-12), which are located along the northwestern side of the lagoons. 1,1-Dichloroethane was found in March/April at 2 μg/l and in July at 3 μg/l in OW-11. The VOCs found in OW-12 occurred only in July and consisted of MIBK at 1 μg/l and 1,1,2,2-PCA at 3 μg/l. During the Phase 1A RI (CDM, 1987), no chlorinated VOCs were found in OW-11 and OW-12, but xylenes were detected (10 and 7 μg/l, respectively). No VOCs were found in the downgradient well (OW-21) located along the northeastern side of lagoons or in the vicinity well (OW-14). Tetrachloroethene was detected previously in OW-14 at a concentration of 3 μg/l, while no VOCs were detected previously in OW-21 (CDM, 1987).

A few VOCs were also measured at four of the 10 groundwater-screening locations: 1,1-DCE; 1,2-DCE; PCE; benzene; and *m*-xylene (Figure 4-26). The detection of 1,1-DCE (3.0 and 0.9 μg/l) occurred at the two screening locations along the southwestern edge of the lagoons (GW-40 and GW-39, respectively). In the southeastern corner of the lagoons, xylene and PCE were measured in GW-32 at 22.5 and 2.6 μg/l, respectively, while benzene was measured at 3.92 in GW-31. There were no detectable concentrations of VOCs in the screening locations along the northwestern, northern, or northeastern perimeter of the lagoons.

The same two chlorinated VOCs that were detected in the deep overburden wells in March/April were also detected at similar concentrations in the same wells in July. 1,1-Dichloroethane was found at 4 μg/l in OW-10 during both sampling rounds and at 10 and 7 μg/l in March/April and July, respectively, in OW-20. 1,2-Dichloroethane was also detected during both sampling rounds at 3 μg/l in OW-20. Chlorinated VOCs were also detected in these wells during the Phase 1A RI (CDM, 1987). The VOCs detected at OW-10 during the Phase 1A RI (CDM, 1987) included 1,1-DCA at 10 μg/l, TCE at 3 μg/l, and *trans*-1,2-DCE, chloroform, and 1,1,2,2-PCA all at 2 μg/l. The VOCs previously detected in OW-20 consist of 1,1-DCA at 16 μg/l, *trans*-1,2-DCE at 7 μg/l, and TCE at 3 μg/l. No VOCs were detected during this RI or previously in vicinity well OW-13, but 1,1-DCA was detected in March/April in the upgradient deep overburden well.

The same chlorinated VOCs that were detected in the two deep overburden wells were also present in the associated bedrock wells during both sampling rounds. Both 1,1- and 1,2-DCA were found in the bedrock well along the northwestern edge of the lagoons (OW-09) at concentrations from 4 to 10 μg/l. Three chlorinated VOCs were also detected at similar concentrations during the Phase 1A RI (CDM, 1987): 1,1-DCA at 20 μg/l, *trans*-1,2-DCE at 5 μg/l; and TCE at 4 μg/l. At MW-209B, the downgradient bedrock well located near the northeastern corner of the lagoons, concentrations of 38 and 39 μg/l were reported for 1,2-DCA. 1,2-Dichloroethane was also detected in the upgradient bedrock well, at concentrations of up to 4 μg/l, during both sampling rounds.

Three SVOCs were detected during the two sampling rounds. Two PAHs were detected in OW-12, 2-methylnaphthalene at 3 μg/l in March/April and 4 μg/l in July and naphthalene at 3 μg/l in only July. The same PAHs were found at OW-12 during the Phase 1A RI (CDM, 1987), but at higher concentrations (17 and 15 μg/l). In addition, dimethylnapthalene and tetramethylbenzene isomers and benzoic acid were tentatively identified in OW-12. Bis(2-ethylhexyl)phthalate was detected in March/April at 3 μg/l in the shallow and deep overburden wells (OW-11 and OW-10, respectively) from the OW-09/10/11/12 cluster, whereas 1,2-DCB was detected in July at 2 μg/l in the bedrock well (OW-09) from the same cluster. During the Phase 1A RI (CDM, 1987), 4-methylphenol at 110 μg/l, naphthalene at 33 μg/l, and 2-methylnaphthalene at 44 μg/l were detected in OW-11. 4-Methylphenol was also reported at 11 μg/l in OW-9 (CDM, 1987). Also detected in the other downgradient bedrock well, MW-209B, was the TIC 1-butoxy-2-propanol, which is commonly known as propylene glycol, an automotive antifreeze component.

Twelve pesticides were detected during the two sampling rounds, most of which were identified in deep overburden wells. Individual pesticide concentrations ranged from 0.0004 to 0.005 μg/l. The only pesticides detected in the shallow overburden wells were heptachlor epoxide in March/April and DDE in July at OW-11. Pesticides were detected in each of the three deep overburden wells, with eight pesticides detected in the two downgradient wells (OW-10 and OW-20) and two pesticides detected in the vicinity well (OW-13). The six pesticides found in March/April in OW-20 include *delta*-BHC, heptachlor epoxide, endosulfan sulfate, aldrin, endrin ketone, and *gamma*-chlordane. Two of the same compounds (*delta*-BHC and *gamma*-chlordane) and endrin were detected in July in OW-20. Three of the same pesticides found at OW-20 in March/April were also found at OW-10 in March/April (heptachlor epoxide, endosulfan sulfate, and aldrin) along with endosulfan I, whereas no pesticides were identified at OW-10 in July. The samples that were collected from the deep overburden well OW-13 contained DDD in March/April and DDE in July. The only bedrock well where pesticides were identified was OW-09. The five pesticides detected in OW-09 in March/April include heptachlor epoxide, endosulfan II, endosulfan sulfate, and *alpha*- and *gamma*-chlordane. Three different pesticides including *delta*-BHC, DDE and -DDD were found at OW-09 in July. During the Phase 1A RI (CDM, 1987) no pesticides were detected in any of these wells.

The only PCB that was detected during either sampling round was Aroclor 1221, which occurred at OW-09 (0.10 μg/l) in March/April. Petroleum hydrocarbons were not detected in any the downgradient or vicinity wells.

Major metal ion concentrations ranged from 1,010 to 2,630 μg/l for aluminum, from 55.8 to 6,780 μg/l for iron, from 3,160 to 122,000 μg/l for calcium, from 495 to 24,400 μg/l for magnesium, from 1,370 to 293,000 μg/l for sodium, and from 389 to 18,500 μg/l for potassium. Although there was a wide range of concentrations and no obvious trends were apparent between wells or well clusters for major metal ions, concentrations tended to be similar at wells between sampling rounds. Major metal ion concentrations also were generally near ranges detected in the upgradient wells with few exceptions.

Beryllium, barium, manganese and 10 heavy metals were detected over the two sampling rounds. Beryllium was only found in March/April in the deep overburden and bedrock wells from the OW-09/10/11/12 cluster (2.4 and 2.1 μg/l, respectively). Like major metal ions, barium and manganese were detected in all wells at a wide range of concentrations, yet concentrations, which ranged from 6.4 to 159 μg/l for barium and from 5.6 to 8,750 μg/l for manganese, were similar between sampling rounds at individual wells. The one exception was OW-21 in which manganese was detected at 74.1 μg/l in March/April and at 407 μg/l in July. In general, more heavy metals were detected in wells from downgradient clusters than in wells from vicinity clusters. Five to six heavy metals were detected in all of the wells from the OW-09/10/11/12 cluster during both sampling rounds. One to three heavy metals were detected in other wells in March/April, whereas three to five heavy metals were detected at most of these wells in July.

More heavy metals were found at OW-12 in March/April than at the other downgradient and vicinity wells. Detected at OW-12 in March/April were arsenic at 16.1 μg/l, chromium at 8.2 μg/l, copper at 22.4 μg/l, lead at 63.6 μg/l, and zinc at 39.5 μg/l. Three of these metals were also detected in other wells: arsenic (13.6 μg/l) in OW-11, chromium (6.8 μg/l) in the vicinity well OW-14, and zinc (141 μg/l) in OW-21. In addition, cobalt was detected at OW-11 (2.4 μg/l). In July more metals were found in OW-11 and OW-21 than in OW-12. Cobalt at 1.6 and 3.5 μg/l and nickel at 2.4 and 10.0 μg/l were both detected in OW-11 and OW-21, respectively. Silver (0.75 μg/l) and zinc (63.4 μg/l) were only detected in OW-21. Lead was detected at 2.0 μg/l in

OW-11 and vanadium was detected at 1.0 $\mu g/l$ in OW-12. Arsenic was found in both OW-11 and OW-12 at 12.1 and 23.4 $\mu g/l$, respectively.

Compared to shallow overburden wells a fewer number of heavy metals were detected in deep overburden wells during both sampling rounds. Cobalt was detected in all three of the deep overburden wells at similar concentrations during both sampling rounds, from 4.1 to 54.7 $\mu g/l$. Nickel was also detected in all deep overburden wells in July (8.4 to 49.9 $\mu g/l$). Most of the other heavy metals that were detected occurred in one or both of the two downgradient wells, OW-10 and OW-20. Zinc was found in both OW-10 and OW-20 in March/April (106 and 6.0 $\mu g/l$, respectively), but, in July, was detected in only OW-10 at 113 $\mu g/l$. Arsenic was detected at 12.0 $\mu g/l$ in March/April and at 17.3 $\mu g/l$ in July at OW-20. Copper was detected in March/April (7.0 $\mu g/l$) and in July (8.7 $\mu g/l$) at OW-10. Cadmium at 1.3 $\mu g/l$ was also found in July at OW-10. In addition, chromium (1.4 $\mu g/l$) was detected in July at OW-13, a vicinity well.

Heavy metals similar to those found in the deep overburden wells were also detected in the bedrock wells. Except for the detection of lead (1.7 $\mu g/l$) at MW-209B in July, all of the other heavy metals detected during the two sampling rounds occurred in OW-09. The heavy metals that were detected in March/April at OW-09 include copper and lead at 14.6 and 21.0 $\mu g/l$ respectively, and cobalt, nickel, and zinc from 99.1 to 147 $\mu g/l$. Several of these metals were also detected at OW-09 at similar concentrations in July: copper at 7.9 $\mu g/l$ and cobalt, nickel, and zinc from 122 to 166 $\mu g/l$. In addition, cadmium (2.1 $\mu g/l$) was found at OW-09 in July.

Beryllium and five of the heavy metals that were detected were not found in any of the upgradient wells: cadmium, chromium, copper, nickel, and zinc. Although the other heavy metals were found in at least one of the upgradient wells, they were not necessarily detected during the same sampling round or in wells from the same groundwater flow zone. Of the metals detected during the two sampling rounds, arsenic was the only metal previously detected in any of the existing wells. As reported by CDM (1987), arsenic was found from 19 to 40 $\mu g/l$ in OW-11, OW-12, and OW-20.

Cyanide was not detected in any of the wells during either sampling round. Other WQPs were also analyzed in March/April in wells from the OW-20/21/MW-209B cluster. Alkalinity values up to 108 mg/l $CaCO_3$ were measured in wells from this cluster, while hardness values of 8 to 1,787 mg/l were calculated for all of the wells. Even though chloride concentrations were substantially higher in the deep and overburden wells (746 and 119 mg/l) compared to the shallow overburden well (5.5 mg/l), NO_3/NO_2 was only detected in the shallow overburden well (0.45 mg/l). Sulfate concentrations increased from the shallow overburden to the deep overburden and bedrock wells (19 to 122 mg/l), while total P concentrations decreased (0.45 to 0.023 mg/l). Biological oxygen demand was not detected in any of the wells and COD was detected only in the deep overburden well (22 mg/l). The TDS and TSS values varied greatly between wells ranging from 39 to 1,200 mg/l and from 0.5 to 6.2 mg/l, respectively. Total organic carbon values of 0.6 to 6.2 mg/l were measured.

Like metals, there was little variation between field parameter values between sampling rounds for individual wells, although marked differences were evident between wells. The highest pHs were measured in shallow overburden wells (6.0 to 8.3) and decreased for deep overburden (4.3 to 6.6) and bedrock wells (4.9 to 6.9). Specific conductance was more elevated in the deep overburden and bedrock wells (270 to 2,500 μmhos/cm and 580 to 2,000 μmhos/cm, respectively) compared to the shallow overburden wells (27 to 320 μmhos/cm). Dissolved oxygen levels from 0.1 to 6.6 mg/l and Eh values from -293 to 210 mV were measured. Turbidities did not exceed 3 NTU.

Summary of Findings. Although M&E did not conduct surface or subsurface soil investigations in the Asbestos Lagoons area, organic and metal contamination was discovered during early investigations conducted in the late 1980s by CDM (1987) and GZA (1987). The results of the investigations are summarized in the PCB Contamination Evaluation Report (M&E, 1994b) presented in Appendix A. The types of contaminants found during the investigations include: toluene, PAHs, PCBs, and heavy metals in soil and PCE, bis(2-ethylhexyl)phthalate, PCBs and heavy metals (cadmium, copper, nickel, and zinc) in groundwater. All of these investigations were conducted to evaluate potential impacts from the stormwater drain system on the subsurface environment and surface water and sediment in the Middlesex Canal, which is near the Asbestos Lagoons.

The types of organic compounds found in groundwater in March/April are similar to those found during the 1980s. Tetrachloroethene was detected in a groundwater-screening location near the southeastern corner of the lagoons and three other chlorinated VOCs (1,1,2,2-TCA, 1,1-and 1,2-DCA) were detected during each sampling round in at least one of the downgradient wells from each groundwater flow zone. The highest concentrations tended to occur in the deep overburden wells. Furthermore, a few PAHs, bis(2-ethylhexyl)phthalate and PCBs, were found in groundwater, as were pesticides.

Heavy metals commonly found across groundwater flow zones and during both sampling rounds, including arsenic, cobalt, lead, and zinc. The detected organic compounds and heavy metals were primarily found in downgradient wells near the northeastern and northwestern corners of the lagoons (OW-09/10/11/12 and OW-20/21/MW-209B). In contrast, more VOCs were detected in the shallow groundwater-screening locations in the southeastern and southwestern corners of the lagoons.

Although no specific information is available as to the types of chemicals that may have been disposed of in the lagoons, the manufacturing of plasterboard during Johns-Manville operations, may have included solvents and other organic chemicals. Surficial soil data from the two outside lagoons (section 4.2.4.3) indicated the presence of pesticides, at concentrations considered to be representative of past widespread applications, but none of the organics were detected in groundwater. Nonetheless, the slurry wastes that were disposed of into the lagoon occurred over many years and may have had differing chemical compositions during that period. Therefore, it is not conclusive as to whether the organic compounds and heavy metals detected in groundwater are migrating from the lagoons. Furthermore, the similarities between some of the organic compounds and heavy metals detected in the downgradient wells and in soil and groundwater near the stormwater drain system suggest that the stormwater drain system may be a potential source or have contributed to subsurface materials in the past.

4.2.2.7 Summary of Groundwater Contamination. Groundwater was chemically characterized at five of the areas of concern: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and the Asbestos Lagoons. The chemical composition of groundwater was found to vary with the different areas of concern, largely because of the different disposal activities that have taken place at each area. In general, the types of organic compounds and metals detected in groundwater were similar to those detected in soil at each of the areas of concern. Volatile organic compounds, primarily aromatic and chlorinated VOCs, were more frequently detected and were present in higher concentrations than other types of organic compounds that were detected, including SVOCs (PAHs, phenolics, and phthalates), pesticides, PCBs, and petroleum hydrocarbons. This is most likely because VOCs are more soluble than these other types of organic compounds; therefore, VOCs tend to more easily leach from soils and waste sources to groundwater. The other types of organic compounds generally are less soluble and are more strongly adsorbed to soil and organic materials.

The types of metals detected and the concentrations found varied between the five areas of concern. Field quality parameters from wells across the Site, indicate that geochemical conditions were similar between the sampling rounds. Aluminum and iron, which are prevalent in soil throughout the Site, when detected in groundwater, were either absent or present at relatively low concentrations, indicating that these metals are not dominant in dissolved phase. A number of heavy metals that were detected have likely originated from waste sources within some of the areas of concern and include arsenic, chromium, manganese, lead, and zinc.

The types of organic compounds, particularly VOCs, and the concentrations detected are similar between this RI and the Phase 1A RI (CDM, 1987) for many of the existing wells. For metals, comparison of data between the two RIs does not yield much information as most of the metals data from the Phase 1A RI, especially for heavy metals, was rejected during validation.

Another similarity noted between the two RIs was that more organic compounds tended to be detected at higher concentrations in the deep overburden wells associated with each of the areas of concern. However, no specific plumes were apparent because of the large variety of different organic compounds that were detected between sampling rounds in individual wells and the irregularity with which different types of organic compounds were detected in wells screened across the same groundwater flow zones in each of the areas of concern.

Organic compounds other than VOCs that were detected in groundwater at each of the areas of concern, were also found in soil at each of the respective areas of concern. This indicates that the waste areas within the areas of concern are, in most cases, the likely source of these contaminants. Although there is potential for the free product layers to form with the types of organic compounds detected, the concentrations are relatively low in comparison to concentrations that are indicative of free product formation. In addition, free product was not visually observed during installation of monitoring wells or piezometers, groundwater sampling, or water level measurements, except at one existing piezometer (P-12), adjacent to the Penn Culvert property.

At the B&M Railroad Landfill, aromatic and chlorinated VOCs, PAHs, pesticides, PCBs, and elevated metal concentrations were detected in groundwater from well clusters associated with this landfill. The organic compounds and elevated metals concentrations were more prevalent at the MW-213 and MW-214 clusters, which are located within the southern half of the landfill, than at the MW-215 cluster, which is located north of the other clusters. However, the presence of similar VOCs and metals in the OW-49/50 cluster, indicate that contaminants are migrating downgradient, below B&M Pond. Since the MW-01/1A/1B/1C cluster is not directly downgradient of the landfill, it is unknown whether the contaminants have migrated as far as Richardson Pond. However, no organic compounds were detected at the MW-01/1A/1B/1C cluster.

At the RSI Landfill, the presence of elevated concentrations of vinyl chloride and dichlorinated VOCs directly downgradient of landfilled wastes and near the top of the water table (groundwater-screening locations) are indicative of the degradation of wastes within the landfill that would result in the release of these organic compounds. It is likely that these typical landfill indicators are being volatilized to soil gas at the unsaturated/saturated zone interface, since these VOCs were not as readily detected in the other groundwater flow zones, including the shallow overburden flow zone. Furthermore, vinyl chloride typically exists as a gas under normal environmental conditions and its presence near the top of the water table suggests that there is probably substantial interaction between soil gas and groundwater occurring at this interface. It also appears that the elevated concentrations of aromatic VOCs (benzene and xylenes) that were found at the OW-07/08 cluster are not related to the RSI Landfill, because of the differences between the concentrations and types of VOCs detected at the OW-07/08 cluster and the other clusters that are directly downgradient of the landfill. In addition, the OW-07/08 cluster was not found to be hydrogeologically downgradient of the RSI Landfill and is probably more hydrogeologically affected by the Johns-Manville Asbestos Landfill. In addition to VOCs, the other types of organic compounds detected in groundwater associated with the RSI Landfill include pesticides and PCBs that were found in relatively low concentrations. Of the heavy metals detected in wells downgradient of the landfill, all but selenium and zinc were found in the upgradient wells.

One VOC, a few pesticides, and a PCB Aroclor were the only organic compounds detected in groundwater associated with the B&M Locomotive Shop Disposal Areas. However, groundwater data from the upgradient well indicate that sources other than the two disposal areas may be affecting downgradient groundwater. Mercury and copper were the only detected metals that were not found in the upgradient wells.

None of the VOCs, PAHs, or petroleum hydrocarbons that would be expected to be found in groundwater at the Old B&M Oil/Sludge Recycling Area were detected. In addition, there were no visual observation of free product during drilling or sampling activities, although floating product was observed in nearby piezometer during water level measurements. Instead, a few chlorinated VOCs were found in groundwater at well clusters downgradient of the two main disposal areas that were delineated within this area of concern. Although, the source of these VOCs is not known, they may be related to maintenance wastes that could have been dispose[illegible] [illegible]uring past activities at this area of concern. In addition, barium and manganese were [illegible] at elevated concentrations in wells from all of the groundwater flow zones. Mor[illegible] metals were found in shallow overburden groundwater than in either deep overbur[illegible] [illegible]ock groundwater flow zones. The heavy metals detected include arsenic, chromium[illegible] [illegible]ad, mercury, nickel, and zinc.

The types of organic compounds found in groundwater from the Asbestos Lagoons is similar to those found during the studies conducted in this area during the 1980s. Aromatic and chlorinated VOCs were both detected; however, chlorinated VOCs were more prevalent. Several chlorinated VOCs (PCE; 1,1,2,2-TCA; 1,1-and 1,2-DCA) were detected in all three groundwater flow zones, specifically in wells the northeastern and northwestern corners of the lagoons. In comparison, VOCs found in the shallow groundwater-screening locations occurred in the southeastern and southwestern corners of the lagoons. As with the 1980s studies, a few PAHs, phthalates, and PCBs were also detected in groundwater. Heavy metals commonly found in all groundwater flow zones include arsenic, cobalt, lead, and zinc. Although no specific information is available as to the types of chemicals that may have been disposed of in the lagoons, the manufacturing of plasterboard during Johns-Manville operations may have involved solvents and other organic chemicals, as well as metals. However, the similarities between some of the organic compounds and heavy metals detected in the downgradient wells and in soil and groundwater near the stormwater drainage system suggest that the stormwater drainage system may be a potential source of these contaminants.

4.2.3 Site-Wide Surface Water

During the recent field investigation, site-wide surface water was sampled during June and September 1993. The June sampling round, which took place from the 9th through the 22nd, corresponded with a period of high flow, whereas the September round (from the 14th through the 22nd) was associated with lower flow conditions. During June, 46 locations were sampled, while 42 were sampled during September. An effort was made to sample each surface water location during both rounds; however, SW-108, SW-109, SW-311, and SW-022, were not sampled during September 1993 because of dry conditions. In September, surface water location SW-319 could not be located, so a new location, SW-319A, was established and sampled. Surface water sampling locations and sample collection periods are summarized in Table 2-13.

At most surface water locations, samples were collected directly into sample containers that were slowly submerged below the water surface to a depth of approximately 6 inches (section 2.2.3). Due to insufficient surface water at SW-311 in September, it was necessary to dig a small hole and allow surface water to infiltrate prior to collection of the sample. However, too little water was obtained within a reasonable period to allow for collection of sufficient sample volume for any analyses at this location. Surface water samples from both sampling rounds were submitted for analysis of the following parameters:

- VOCs
- SVOCs
- Pesticides and PCBs
- Metals (unfiltered)
- Cyanide
- TOC
- Alkalinity

Hardness was calculated for each sample using magnesium and calcium concentrations that were reported with the metals data. Other water quality parameters measured during field activities include pH, specific conductance, temperature, and DO.

For the purpose of discussing surface water data, surface water locations have been grouped by their geographic location within the Site, primaril[illegible]d on the waterbody in which the locations are situated. The groupings are shown in Figure 4-33. The analytes detected in surface water samples are summarized in Table 4-24. The predominant types of organic compounds and metals detected are presented in Figures 4-34 through 4-37.

4.2.3.1 Background Locations. Three background surface water samples (SW-319, SW-319A, and SW-321) were collected from various waterbodies adjacent to the Site. Surface water locations SW-319 and SW-319A were sampled in the wetland area west of High Street. Location SW-319 was sampled location during June 1993 (high flow); however, a new location, SW-319A, which is situated in the same wetland area, northwest of the original location, was sampled in September. Surface water samples were collected from the same SW-321 location during both June and

September (i.e., north of the Site in a marshy brook, off of Burnham Road at the end of a cul-de-sac in a residential area).

A few organic compounds were detected at the background locations; however, detected concentrations were below SQLs. Neither VOCs nor PCBs were detected at the background locations during either round. Pesticides were the only organic compounds detected at SW-319 and SW-319A. Endosulfan II and *alpha*-chlordane were found in June (0.0011 and 0.00075 μg/l, respectively), whereas endrin aldehyde was detected in September at 0.006 μg/l.

Both PAHs and pesticides were detected at SW-321. During the high-flow period in June, four PAHs were found at SW-321: benzo(b)fluoranthene (0.7 μg/l), fluoranthene (0.6 μg/l), phenanthrene (0.6 μg/l), and pyrene (0.9 μg/l). Fluoranthene and pyrene at 1 μg/l were also reported during the low-flow period in September. Since SW-321 is situated in a residential area near a cul-de-sac, it is possible that vehicular- or road-related activities are affecting this location. In September, four pesticides were also detected: DDE at 0.006 μg/l, *alpha*-BHC at 0.002 μg/l, and chlordanes (*alpha*- and *gamma*-) at 0.009 and 0.011 μg/l, respectively. As discussed earlier, the widespread occurrence of pesticides in areas adjacent to the industrial park has likely resulted from urbanization and industrial operations as well as residential uses in the local area.

Major metal ion concentrations were similar between rounds at SW-319 and SW-319A (June and September, respectively) with aluminum at 1,580 and 888 μg/l, iron at 2,970 and 2,830 μg/l, calcium at 11,000 and 9,980 μg/l, magnesium at 2,530 and 2,120 μg/l, sodium at 26,200 and 23,100 μg/l, and potassium at 2,190 and 2,480 μg/l. Barium (33.1 and 37.7 μg/l) and three heavy metals were also detected at SW-319/319A during both rounds: lead (22.3 and 32.4 μg/l), manganese (350 and 315 μg/l), and zinc (27.8 and 66.6 μg/l). Chromium at 3.5 μg/l and nickel at 5.1 μg/l were found in June, while copper at 7.8 μg/l was found in September.

Major metal ion and other metal concentrations were generally higher at SW-321 than at SW-319/319A during both rounds. In addition, concentrations at SW-321 tended to be higher for September in comparison to June. For example, concentrations of 6,290 and 18,500 μg/l for aluminum, 27,000 and 71,200 μg/l for iron, 24,800 and 27,900 μg/l for calcium, 4,930 and 6,570 μg/l for magnesium, 37,200 and 23,000 μg/l for sodium, and 3,530 and 4,500 μg/l for potassium were reported for June and September, respectively. Also detected in both rounds (June and September, respectively) were barium (155 and 285 μg/l), beryllium (1.1 and 2.8 μg/l), and eight heavy metals: arsenic (18.1 and 39.8 μg/l), chromium (9.9 and 25.9 μg/l), cobalt (33.2 and 72.5 μg/l), lead (40.9 and 122 μg/l), manganese (5,840 and 6,740 μg/l), nickel (18.6 and 48.2 μg/l), vanadium (19.0 and 49.1 μg/l), and zinc (158 and 505 μg/l). Thallium at 2.9 μg/l was detected only in September.

Cyanide was not detected in background surface water samples. Except for hardness and DO, WQPs were similar at both background locations in June. Specific conductances of 200 to 280 μmhos/cm, alkalinities of 30 and 41 mg/l $CaCO_3$, and pHs of 6.6 and 7.0 were measured at SW-319 and SW-321, respectively. Alkalinities were measured as 12 mg/l $CaCO_3$ at SW-319A and 34 mg/l $CaCO_3$ at SW-321 in September, and pH was 8.7 at SW-319A and 7.2 at SW-321. In June, a DO value of 2.9 mg/l was measured at SW-319, while values of 6 to 6.5 mg/l were recorded in September. In both rounds, hardness was similar at each background location but higher at SW-321 (82 and 97 mg/l) than at SW-319 (38 and 34 mg/l). Total organic carbon was reported as 18 mg/l at SW-319 and 11 mg/l at SW-321 in June. In September, TOC was reported as 18 mg/l for SW-319A and 8 mg/l for SW-321.

In summary, the presence of pesticides at background surface water locations demonstrates the ubiquitous nature of these types of chemicals in urban residences located near industrialized areas. The types of pesticides detected were also widely used on lawns and gardens before they were banned in the 1980s. The PAHs are possibly attributed to vehicular- or road-related activities since the sampling location, SW-321, is located in a residential area near a cul-de-sac.

4.2.3.2 Site-Wide Locations. Site-wide surface water samples were collected to characterize the impact of source areas (landfills, disposal areas, etc.) on various waterbodies within the Site. Surface water data are discussed in terms of the location groupings, to the west and east of Pond Street, as described above and as presented in Table 2-13 and Figure 4-33.

B&M Pond (West of Pond Street). The B&M Pond is approximately 3.5 acres in size and is connected to both the northern and southern portions of the Middlesex Canal. Three surface water locations are included in this grouping. Two surface water locations, SW-107 and SW-304, were sampled from the B&M Pond during June and September. Samples at SW-304 were collected approximately 20 feet from the eastern boundary of the B&M Railroad Landfill. Samples for SW-107 were collected in the eastern portion of the pond, directly off Pond Street. The third surface water location in this grouping is SW-017, which is located in the Middlesex Canal, directly west of Pond Street.

Drainage Ditch (West of Pond Street and West of B&M Railroad Landfill). A drainage ditch, located on the eastern side of the Old B&M railroad spur area is approximately 3 feet wide and 1,100 feet long. A culvert from the west discharges to the ditch. Surface water samples were collected during June and September from two locations in this ditch, SW-305 and SW-306. Surface water location SW-305 was sampled from a ponded area of the drainage ditch near the culvert. Surface water location SW-306 is also situated in the drainage ditch, approximately 300 feet southwest of SW-305.

B&M Locomotive Shop Disposal Areas (West of Pond Street and the Man-Made Canal). Surface water location SW-317 was sampled during June and September. This is a new location chosen by M&E and EPA during the recent field investigation. It is located in the man-made canal, which separates the two areas within the B&M Locomotive Shop Disposal Areas. The unnamed brook discharges to this canal. The surface water sample at SW-317 was collected from a ponded area, approximately 3 to 4 feet in depth, which is relatively stagnant. Abandoned, deteriorating 55-gallon drums were observed in the immediate vicinity of this location.

North of Spincraft (West of Pond Street). Historic surface water location, SW-109, was sampled only in June. No sample was collected in September because there was insufficient surface water. This location has also been sampled during past field investigations. Surface water location SW-109 is situated in a brook north of Spincraft. The brook flows south from the northern portion of the

Middlesex Canal under the industrial park access road. The sampling location is situated directly north of the access road near a culvert. During the June sampling, water levels in the brook were low and flow was slow.

RSI Wetland Area (West of Pond Street). Five surface water locations (SW-016, SW-108, SW-301, SW-302, and SW-303) were sampled in the immediate vicinity of a wetland area and in the Middlesex Canal, which are northeast of the RSI Landfill. Locations SW-108 and SW-301 were situated in the wetland area, while SW-016, SW-303, and SW-302 were located in the Middlesex Canal, north of the wetland. Surface water was collected from all five locations in June and all locations except SW-108 in September. Location SW-108 was not sampled in September because of insufficient surface water.

Unnamed Brook (West of Pond Street and North of the B&M Locomotive Shop Disposal Areas). Four surface water locations (SW-010, SW-013, SW-118, and SW-322) were sampled during June and September from the unnamed brook, south of the RSI Landfill. Three of these locations (SW-010, SW-013, and SW-118) are directly in the unnamed brook, while the fourth, SW-322, is situated in a sedimentation pond directly connected to the unnamed brook. The southerly flow of water in the unnamed brook is relatively slow and, in some places, stagnant. The sedimentation pond contains stagnant water, held within the pond by booms and a make-shift dam structure. During both sampling rounds, an oily sheen was observed on the surface of the pond and strong organic odors were noted. The purpose of the sedimentation pond is not known; however, a submerged 6-inch PVC pipe was found at the southwestern edge of the pond. The sample from SW-322 was collected at the base of the PVC pipe. The origin of this pipe is unknown. Local railroad workers in the area reported that wildlife (turtles) have been observed in the sedimentation pond, and that the pond does not freeze over in the winter (Springfield Railroad, 1993).

Middlesex Canal (West of Pond Street). Five surface water locations (SW-026, SW-028, SW-029, SW-307, SW-308) were collected from the northern portion of the Middlesex Canal during June and September. Two of the surface water locations, SW-307 and SW-308, were newly identified by M&E and EPA during the site reconnaissance (section 2.1.1.6). The remaining three (SW-026, SW-028, and SW-029) are historic locations that have been sampled during past field investigations.

Surface water location SW-026 is situated at the intersection of Middlesex Canal and the brook that flows south to the industrial park access road (the same brook in which SW-109 is located). Surface water location SW-307 is farther east along the Middlesex Canal in the old barge turnout area. Continuing east in the Middlesex Canal, SW-308 is located in the canal at the base of an old discharge pipe originating from the former Johns-Manville property (BNZ, 1993). This discharge pipe is no longer in use and has been permanently plugged. This approximate area was investigated by BNZ because elevated levels of PCBs were found in catch basins and storm drains of the manufacturing buildings as well as in canal sediments (GZA, 1987).

Two additional locations, SW-028 and SW-029, are situated at the northeastern most portion of the Middlesex Canal, directly north of the railroad spur area. The canal is overgrown and heavily silted in this area.

Content Brook (East of Pond Street). Five surface water locations (SW-030, SW-101, SW-102, SW-113, and SW-117) were sampled in Content Brook in June and September. Surface water locations SW-113, SW-117, and SW-030 were sampled from the upstream portion of Content Brook on the eastern side of the Shaffer landfill. Content Brook flows into the Middlesex Canal just downstream of SW-030. Surface water locations SW-102 and SW-101 are situated in Content Brook, in marshy wetland areas. SW-102 is adjacent to Gray Street and SW-101 is adjacent to the commuter rail line.

Middlesex Canal (East of Pond Street). In June, seven surface water locations (SW-019, SW-020, SW-103, SW-104, SW-105, SW-106, and SW-116) were sampled in the section of the Middlesex Canal that is east of Pond Street. These seven locations are in the southern portion of the Middlesex Canal. The Middlesex Canal is overgrown and heavily silted, making navigation of the canal difficult. Most parts of the canal are not passable by boat.

Richardson Pond (East of Pond Street). Seven surface water locations (SW-022, SW-111, SW-309, SW-314, SW-315, SW-316, and SW-320) were sampled from Richardson Pond during June. All locations except SW-022 were also sampled in September. Richardson Pond is a large swampy, wetland area located in the northeastern portion of the Site. The pond is bordered to the north by residential properties, to the east by woods, to the south by the commuter rail line, and to the west by Pond Street. Access to the pond is difficult from all directions, except the north. Residential properties on Raymond Street, which is a side street to Gray Street, have direct access to the pond. The depth of the water in the pond was a maximum of 3 feet, and during both sampling rounds it was swampy and mucky.

Shaffer Landfill Wetlands (East of Pond Street). Four surface water locations (SW-310, SW-311, SW-312, and SW-313) were sampled during June. With the exception of SW-311, the same locations were sampled during September. Surface water samples from locations SW-310 and SW-313 were collected from wetlands on the eastern side of the Shaffer landfill. Oily and orange discolored water was observed in this area suggesting that the landfill may be contaminating the wetlands. The SW-312 samples were collected from a leachate pond located at the center of the landfill between the lobes. At the point of sampling, the surface water was approximately 3 feet deep; however, the pond appeared to deepen towards the center. The surface water sample from location SW-311 was collected from a marshy area that was relatively dry. To obtain surface water from this location, it was necessary to dig a small hole and allow surface water to infiltrate. During the September sampling event, SW-311 was extremely dry; therefore, a surface water sample was not obtained. Orange discoloration of nearby soil and surface water as well as oily sheens were observed at all locations in the Shaffer Landfill Wetlands.

Contaminant Trends. Several VOCs were detected at a few locations during both sampling rounds. Members of the BTEX compounds were found at several locations in Richardson Pond and the Shaffer Landfill Wetlands during both rounds. In June, BTEX compounds were found at four locations: SW-316 in Richardson Pond and SW-310, SW-311, and SW-313 in the Shaffer Landfill Wetlands. Xylenes were reported at all four of the locations at concentrations ranging from 11 to

120 μg/l. Other BTEX compounds were also found at two of the Shaffer Landfill Wetland locations: toluene at 8 μg/l and ethylbenzene at 42 μg/l in the sample from SW-313 and toluene at 26 μg/l in the sample from SW-311.

In September, BTEX compounds were found at five locations (SW-117 in Content Brook, SW-316 and SW-320 in Richardson Pond, and SW-310 and SW-312 in the Shaffer Landfill Wetlands). When detected, concentrations were 10 μg/l or less. Toluene was detected in the sample collected from Content Brook and the two samples collected in Richardson Pond. Benzene was found at SW-320 (Richardson Pond) and SW-310 (Shaffer Landfill Wetlands). Xylenes were also detected in the two samples collected from the Shaffer Landfill Wetlands (SW-310 and SW-312). In addition, chlorobenzene was detected at SW-312 (1 μg/l) and at SW-322 (2 μg/l), which is located at the base of the discharge pipe in the sedimentation pond that is adjacent to the unnamed brook.

Chlorinated VOCs were also detected in several surface water samples. Among samples collected in June, the only one in which chlorinated VOCs were detected was from SW-322 (sedimentation pond). The chlorinated VOCs that were identified in this sample consist of 1,1,1-TCA at 20 μg/l, 1,2-DCE at 11 μg/l, PCE at 16 μg/l, and trichloroethene (TCE) at 8 μg/l. The same chlorinated VOCs were again detected at similar concentrations at SW-322 in September: 1,1,1-TCA at 17 μg/l, 1,2-DCE at 12 μg/l, PCE at 12 μg/l, and TCE at 9 μg/l. In addition, 1,1-DCA was found at 11 μg/l in SW-322. During sampling an oily sheen was observed on the surface of the pond as well as strong organic odors. The oily sheen and odors are believed to originate from the discharge pipe. 1,1,1-Trichloroethane, which had the highest concentration at SW-322, was also found at four other locations: SW-017 (Middlesex Canal associated with the B&M Pond), SW-301 and SW-302 (RSI Wetland Area), and SW-118 (unnamed brook). In addition, PCE was detected at 2 μg/l in SW-013, and 1,1-DCA was detected at 2 μg/l in SW-118.

In addition to aromatic and chlorinated compounds, several VOCs that are gases under normal conditions were found at concentrations of 5 μg/l or less. Carbon disulfide was detected in two samples (SW-102, located in Content Brook, and SW-317, located in the man-made canal) and chloromethane was found in SW-111 (located in Richardson Pond).

Although detected in both sampling rounds, PAHs were found only at 12 surface water locations, at individual concentrations of 4 $\mu g/l$ or less. Eight PAHs were identified in June: naphthalene, acenaphthene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, and benzo(b)fluoranthene. Four of these were also detected in September. Naphthalene, phenanthrene, fluoranthene, and pyrene were the most often detected, each occurring in five to seven samples in June. The locations where multiple PAHs occurred (SW-022, SW-111, and SW-310) were usually near roads or the train tracks. Several PAHs were also found at SW-311, which is located between the two Shaffer Landfill lobes. Total PAH concentrations in each sample were less than 10 $\mu g/l$. Similar levels and types of PAHs were also found at one of the background surface water locations (SW-321).

Four phenolic compounds were detected in June: phenol, 2-methylphenol, 4-methylphenol, and 2,4-dimethylphenol. Concentrations of 96 $\mu g/l$ for phenol, 2 $\mu g/l$ for 2-methylphenol, 43 and 440 $\mu g/l$ for 4-methylphenol, and 7 $\mu g/l$ for 2,4-dimethylphenol were reported. These compounds occurred at three locations in the wetlands east of the Shaffer Landfill Wetlands (SW-310, SW-311, and SW-313) and in one location in Content Brook (SW-030), which receives discharge from the Shaffer Landfill Wetlands. No phenolic compounds were detected in September.

Two other SVOCs were also found in surface water: 1,4-Dichlorobenzene (1,4-DCB) and BEHP. 1,4-Dichlorobenzene was detected in concentrations of 0.6 to 2 $\mu g/l$ at locations exhibiting PAHs (SW-312 and SW-313 in the Shaffer Landfill Wetlands). Bis(2-ethylhexyl)phthalate was detected in June in only four samples (SW-311, SW-306, SW-019, and SW-013) at concentrations ranging from 0.5 to 190 $\mu g/l$.

Although pesticides were detected in both sampling rounds at similar individual concentrations, a greater number of different pesticides were detected in June. September data for pesticides were rejected in six samples, as discussed in section 2.3.2. In June, 16 different pesticides were detected at 29 surface water locations, whereas only eight pesticides were detected at five locations in September. Concentrations ranged from 0.00063 to 0.066 $\mu g/l$ in June and from 0.0030 to 0.025 $\mu g/l$ in September. Pesticides detected in June include: BHCs (*alpha-*, *delta-*, and *gamma-*), DDD, DDT, methoxychlor, heptachlors, endosulfans (I and II), aldrin, dieldrin, endrin, endrin aldehyde, and chlordanes (*alpha-* and *gamma-*). Total pesticide concentrations in each sample ranged from 0.001 to 0.083 μg/l. Generally, between one and four different pesticides were found in each sample; however, samples from the wetlands to the east and west of Shaffer Landfill (SW-310, SW-311, and SW-312) had from five to six pesticides in each sample. One or two pesticides in each sample were identified in 18 samples. Endrin and, to a lesser extent *gamma*-BHC, were the most frequently detected pesticides in June; however, endrin was not detected at any location in September.

The eight pesticides detected in September include *alpha-* and *delta*-BHC, DDD, DDT, endosulfan II, endrin aldehyde, and *alpha-* and *gamma*-chlordane. Four pesticides were each found at one of the Shaffer Landfill Wetland locations (SW-313), where only two pesticides were previously found in June. Only one pesticide was detected at three of the other four locations. The fourth location, SW-111, which is located at the southwest corner of Richardson Pond, contained six different pesticides. Total pesticide concentrations for September ranged from 0.005 to 0.051 μg/l; the maximum total concentration and the greatest number of different pesticides (six) were found at SW-111. Similar pesticides were also detected in the background surface water; however, in fewer numbers and at lower concentrations.

No PCBs were detected in June. In September, PCBs were detected in two surface water samples. Aroclor 1248 was found at SW-308 at 0.17 μg/l. This location is in the Middlesex Canal to the west of Pond Street, at the foot of an old discharge pipe originating from BNZ property (formerly Johns-Manville). This approximate area was investigated by BNZ because of elevated levels of PCBs found in catch basins and storm drains associated with the manufacturing buildings, as well as in canal sediments (GZA, 1987). Aroclor 1260 was detected at SW-111, which is located to the southwestern edge of the Richardson Pond. This location is directly adjacent to the main commuter rail line. Aroclor 1248 and 1260 were common components of oils and hydraulic fluids.

Concentrations for several of the major metal ions tended to decrease from June to September: aluminum was found at a range of 129 to 65,000 μg/l in June and 17.4 to 41,700 μg/l in September, iron from 653 to 1,290,000 μg/l to 329 to 116,000 μg/l, calcium from 3,330 to 226,000 μg/l and 7,280 to 98,800 μg/l, and magnesium from 942 to 75,300 to 1,610 and 50,200 μg/l. On the other hand, sodium and potassium concentrations increased slightly (10,100 to 333,000 μg/l and 12,600 to 673,000 μg/l for sodium and 996 to 113,000 μg/l and 1,160 to 130,000 μg/l for potassium). In addition to major metal ions, barium and manganese were found in most samples in both rounds. Barium concentrations ranged from 9.3 to 10,300 μg/l in June and 17.2 to 842 μg/l in September. Manganese concentrations ranged from 129 to 35,000 μg/l in June and 59.4 to 3,530 μg/l in September.

Although there were no consistent trends i[illegible]tration between sampling rounds, several heavy metals were detected more often in June than in September. For instance, arsenic was frequently detected in June from concentrations of 1.8 to 13,000 μg/l in 28 samples in June, but from concentrations of 2.5 to 676 μg/l in 16 samples in September. In June, zinc was found in 16 samples from 14.6 to 1,160 μg/l, and in September, in nine samples from 12.9 to 5,100 μg/l, whereas nickel was reported in 22 samples from 4.3 to 134 μg/l and in five samples from 28.4 to 324 μg/l in June and September, respectively. While it was detected less often than the above heavy metals, selenium was found in seven samples in June (2.4 to 27.6 μg/l) and in two samples in September (4.0 to 6.1 μg/l).

Chromium, cobalt, lead, and vanadium, on the other hand, were found as frequently in both rounds. Found in as many as eight to ten samples in June and September, respectively, chromium was detected at concentrations ranging from 4.3 to 133 μg/l and 3.4 to 92.3 μg/l, cobalt at concentrations ranging from 5.5 to 58 μg/l and 4.3 to 27.7 μg/l, and vanadium at concentrations ranging from 2.8 to 211 μg/l and 3.4 to 102.2 μg/l. Lead was also detected at similar concentrations in both rounds: in 14 samples from 16.6 to 632 μg/l in June and in 13 samples from 10.9 to 630 μg/l in September. Detected in four or fewer samples in either sampling round were: beryllium from 0.40 to 4.3 μg/l, antimony from 14 to 30.2 μg/l, cadmium at 28.2 μg/l, copper from 3.7 to 636 μg/l, mercury from 0.15 to 0.27 μg/l, silver from 5.1 to 54.0 μg/l, and thallium from 2.1 to 23.8 μg/l.

Although the number of and concentrations of heavy metals in individual samples varied between sampling rounds, there were no distinct trends. Manganese was the heavy metal detected at the highest concentration in both sampling rounds. For individual metals, the highest concentrations were also associated with many different sampling and geographically defined locations. In particular, SW-030, SW-310, SW-313, all of which are located directly east of the Shaffer Landfill, tended to exhibit the highest concentrations in both rounds.

Cyanide was not detected in either round in any surface water samples. Dissolved oxygen concentrations were generally the same between the two sampling rounds and ranged from 0.6 to 8.5 mg/l. Total organic carbon values were generally higher in June, ranging from 7.1 to 341 mg/l, while September values ranged from 3.7 to 67 mg/l. Values of pH were within the typical range of natural surface waters and were similar in both rounds (4.7 to 7.8). For the most part, specific conductances ranged from the low 100s to less than 1,000 μmhos/cm in June and September. However, specific conductance values greater than 1,000 μmhos/cm occurred at eight locations in June and three of the same locations in September. In particular, specific conductance values were elevated for surface water in the Shaffer Landfill Wetlands (3,400 and 1,700 μmhos/cm for SW-310, June and September, respectively; 6,000 μmhos for SW-311 in June; 7,800 μmhos/cm for SW-312 in June; 2,700 and 2,400 μmhos/cm for SW-313, June and September, respectively), the unnamed brook (24,000 μmhos/cm for SW-013 in June; 1,000 μmhos/cm for SW-118 in June; and 20,000 μmhos/cm for SW-322 in June), and Content Brook (2,500 and 7,600 μmhos/cm for SW-030, June and September, respectively).

4.2.3.3 Summary of Surface Water Contamination. As shown in Figure 4-33 the site-wide surface water locations are situated in different environmental settings across the Site. Some locations, such as those in the Middlesex Canal (both east and west of Pond Street) and Content Brook, were sampled from relatively open, free-flowing channels. In contrast, locations in Richardson Pond were sampled in wetland and swampy environments, and locations in the unnamed brook were sampled in small, almost stagnant channels and adjoining ponded areas. In addition, it is likely that different nearby activities (historical or current) have to some degree affected surface water conditions. As a result, the chemical characteristics of the surface water bodies across the Site greatly varied.

Organic compounds and elevated metal concentrations were detected in surface water locations across the Site. The dominant types of organic compounds detected consist of aromatic and chlorinated VOCs, PAHs, phenolic compounds, and pesticides. While petroleum hydrocarbons were not detected in any of the surface water locations, PCBs were detected only in September at two locations. For the most part, more organic compounds were detected in June than in September. In all, organic compounds were found at 35 surface water locations in June and at 22 locations in September, with at least one organic compound detected in one or more surface water locations from each of the geographically defined groupings (Table 2-13 and Figure 4-33) during one or both sampling rounds. The same types of organic compounds and metals detected in surface water were also found in soils from the various source areas in the industrial park as well as soils and groundwater from nearby areas of concern.

During both sampling rounds, aromatic VOCs were found in locations east of Pond Street, and at Richardson Pond and the Shaffer Landfill Wetlands. Chlorinated VOCs were primarily associated with the surface water location in the sedimentation pond (SW-322), which is south of the RSI Landfill. To a lesser extent, chlorinated VOCs were also detected in nearby surface water locations in the RSI Wetland Area, the Middlesex Canal associated with the B&M Pond, and the unnamed brook. Phenolic compounds and PAHs were detected in locations neighboring railroad tracks, roads, and Shaffer Landfill. These types of organic compounds were more prevalent in June than in September. Pesticides were also more frequently detected in June. Sixteen pesticides were identified in June, compared to the eight identified in September. Pesticides, as well as PAHs, were also present in at least one of the background surface water locations. The presence of pesticides is widespread, with at least one compound detected at 29 of the surface water locations. However, concentrations are indicative of residual levels, which are most likely adsorbed to particulates in the water column. Likewise, the infrequent detections of PCBs at relatively low concentrations suggest that the PCBs are being adsorbed to particulates.

In addition to major metal ions, heavy metals were commonly found at many of the surface water locations as well as at background surface water locations. In total, manganese and 13 other heavy metals were found. In particular, elevated concentrations of chromium, copper, lead, manganese, vanadium, and zinc were found across the Site. Although there were no distinct trends, surface waters in the Shaffer Landfill Wetlands east of the landfill exhibited the most elevated heavy metal concentrations and specific conductances.

In general, the surface water locations where more organic compounds as well as elevated metal concentrations and specific conductances were consistently measured include SW-111 (located at the southwest corner of Richardson Pond, adjacent to the commuter rail line tracks and the bottom of the High Street embankment), Shaffer Landfill Wetland locations (SW-310, SW-311, SW-312, and SW-313), SW-030 in Content Brook, and SW-322 (at the base of a discharge pipe in the sedimentation pond off the unnamed brook.

4.2.4 Site-Wide Sediment

During this RI, site-wide sediment was collected along with surface water during June and September 1993. The June sampling round, which took place from the 9th through the 22nd, corresponded with a period of high flow, whereas the September sampling round (from the 14th through the 22nd) was associated with lower flow conditions. A total of 46 site-wide sediment locations were sampled during June. Only 43 sediment locations were sampled during September because of dry conditions at three locations (SD-109, SD-108, and SD-311). In September, because sediment location SD-319 could not be located, a new location, SD-319A, was established and sampled. One additional location, SD-318, which was sampled only in June at the request of EPA, is situated adjacent to a salt/sand pile in the parking lot north of the B&M Locomotive Shop Disposal Areas. In addition to site-wide sediments, four sediment samples were also collected from the Asbestos Lagoons in June. Sediment sampling locations and collection dates are summarized in Table 2-13.

Sediment samples were collected from 0 to 6 inches using a decontaminated soil auger, as described in section 2.2.4. Sediment was collected from below surface water at all locations, with the exception of SD-311, where surface water was insufficient. Sediment samples from both sampling rounds were submitted for the analysis of the following parameters:

- VOCs
- SVOCs
- Pesticides and PCBs
- Metals
- Cyanide
- TPH
- TOC
- Grain size
- Moisture Content
- TCO

For the purpose of discussing sediment data, sediment locations have been grouped by their geographical location within the Site, primarily determined by the waterbody in which the locations are situated. The groupings are shown in Figure 4-33. The analytes detected in sediment samples are summarized in Table 4-25. The predominant types of organic compounds and metals detected are presented in Figures 4-38 and 4-41.

4.2.4.1 Background Locations. Two background sediment samples (SD-319/SD-319A, and SD-321) were collected from various waterbodies adjacent to the Site. Sediment locations SD-319 and SD-319A were sampled in a wetland area west of High Street. Location SD-319 was sampled during June 1993 (high flow); however, a new location, SW-319A, which is situated in the same wetland area, northwest of the original location, was sampled in September to coincide with the relocation of the corresponding surface water sampling location. During both June and September, sediment was collected from location SD-321, north of the Site in a marshy brook (off Burnham Road at the end of a cul-de-sac in a residential area).

No VOCs were detected in background sediment samples SD-319 or SD-321 in June. In September, 2-hexanone was detected in SD-321 at 31 μg/kg; however, VOCs were not detected in surface water from this location.

In June, nine PAH compounds (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene) were detected in SD-321 and five of these were detected in SD-319. Individual concentrations ranged from 34 to 110 μg/kg, with total concentrations reported as 390 μg/kg for SD-319 and 520 μg/kg for SD-321. Bis(2-ethylhexyl)phthalate was also detected at 140 μg/kg in SD-321 in June. In contrast, only benzo(a)pyrene was detected in SD-319A (290 μg/kg) and only pyrene was detected in SD-321 (130 μg/kg). Similar PAHs were also detected in background surface water for the same periods, especially at SW-321.

Although pesticides and PCBs were detected in background sediment samples in June, none were found in September. Nine pesticides were identified in June. Four pesticides were detected in both samples (DDD, DDE, dieldrin, and *delta*-BHC), while *alpha*- and *gamma*-chlordane and *beta*-BHC occurred only in SW-319, and DDT and endosulfan I occurred only in SD-321. Individual concentrations for DDT, DDD, and DDE ranged from 3.2 to 12 μg/kg, while concentrations for the other pesticides ranged from 0.11 to 1.8 μg/kg. Total concentrations were 27 μg/kg for SW-319 and 16 μg/kg for SW-321. Background surface water and surface soil samples contained pesticides similar to those detected in background sediment samples. The presence of pesticides in background surface water, surface soil, and sediment demonstrates the ubiquitous nature of these types of chemicals in this area. The concentrations of pesticides in sediment samples are within the ranges reported by ASTDR (1989) in residential and urban areas.

One PCB Aroclor was detected in each of the background sediment samples collected in June. Aroclor 1016 was detected in SD-319 at 9.6 μg/kg and Aroclor 1248 was detected in SD-321 at 36 μg/kg. PCBs were not detected in background surface water.

Major metal ion concentrations for both sampling rounds were similar for SD-321. Concentrations of 14,800 and 10,300 mg/kg for aluminum, 6,260 and 5,080 mg/kg for iron, 6,070 and 4,050 mg/kg for calcium, 1,120 and 1,520 mg/kg for magnesium, and 323 and 374 for potassium were reported for SD-321 in June and September, respectively. A similar trend was also apparent at SD-319/319A. For example, concentrations of 5,300 and 2,130 mg/kg for aluminum, 6,590 and 1,340 mg/kg for iron, 1,490 and 3,340 mg/kg for calcium, 1,760 and 500 mg/kg for magnesium in June and September, respectively. In June, at 1,040 mg/kg, potassium was reported. Sodium was also detected, but was not reported for either sampling round because of validation qualifications (section 2.3.2).

Also detected in both rounds (June and September, respectively) were barium (59.1 and 39.1 mg/kg in SD-321 and 26.1 and 30.7 mg/kg in SD-319/319A) and four heavy metals: lead (19.8 and 17.4 mg/kg in SD-321 and 43.0 and 18.8 mg/kg in SD-319/319A), manganese (469 and 388 mg/kg in SD-321 and 98.7 and 32.7 mg/kg in SD-319/319A), vanadium (11.3 and 9.5 mg/kg in SD-321 and 14.4 and 7.2 mg/kg in SD-319/319A), and zinc (38.1 and 26.3 mg/kg in SD-321 and 46.4 and 28.6 mg/kg in SD-319/319A). In June in SD-321, arsenic was detected at 5.0 and at 5.2 mg/kg in SD-319. In September, copper was detected at both background locations (12.8 mg/kg at SD-321 and 20.6 mg/kg at SD-319A) and only at SD-321 (16.9 mg/kg) in June. In addition, beryllium (2.7 and 1.3 mg/kg) and three heavy metals were found at SW-321 during both sampling rounds: chromium at 14.2 and 16.4 mg/kg, cobalt at 6.2 and 4.8 mg/kg, and mercury at 0.29 and 0.16 mg/kg for June and September, respectively.

Cyanide was not detected in background sediment samples. Petroleum hydrocarbons were not reported in background sediment samples in June; however, a concentration of 75 mg/kg was measured at SD-319A in September. Total combustible organics were reported at 11.6% for SD-319 and at 43.1% for SD-321 in June. In September, TCO was reported at 79.4% for SD-319A and 30.4% for SD-321.

4.2.4.2 Site-Wide Locations. As with site-wide surface water, site-wide sediment samples were collected to characterize the impact of source areas (e.g. landfills and disposal areas) on various waterbodies within the Site. Sediment data are discussed in terms of their location groupings, to the west or east of Pond Street, as described for surface water (section 4.2.3.2) and presented in Table 2-13 and Figure 4-33.

Contaminant Trends. Volatile organic compounds, primarily aromatic and chlorinated, were detected in June and September in sediment samples; however, the frequency of detection and the concentrations were generally greater in June than in September. Aromatic VOCs were detected in 14 sediment samples in June and only at eight locations in September. Aromatic VOCs detected in both sampling rounds include: benzene, toluene, ethylbenzene, xylenes, and chlorobenzene. Concentrations in June compared to September, respectively, ranged from 7 to 54 μg/kg and 3 to 19 μg/kg for benzene, 13 to 200 μg/kg and 4 to 41 μg/kg for toluene, 28 to 440 μg/kg and 14 to 30 μg/kg for ethylbenzene, 9 to 990 μg/kg and 9 to 410 μg/kg for xylenes, and 39 μg/kg and 4 to 9 μg/kg for chlorobenzene. In June, all of the locations in which aromatic VOCs were found were situated east of Pond Street: SD-022, SD-309, and SD-316 in the southern portion of Richardson Pond (near the commuter rail); SD-030 and SD-102 in Content Brook; SD-310, SD-311, SD-312, and SD-313 in the Shaffer Landfill Wetlands; and SD-019, SD-020, SD-103 through SD-105 along the Middlesex Canal. At many of these locations, only one or two aromatic VOCs were found, yet three to four VOCs were found at SD-030 (Content Brook), SD-022 (Richardson Pond), and SD-310 and SD-311 (Shaffer Landfill Wetlands). Total concentrations in each sample ranged from 7 to 200 μg/kg at locations having one or two VOCs, whereas total concentrations of 170 to 1,100 μg/kg were measured at locations with three or four VOCs. Similar aromatic VOCs were also detected in surface water samples from Richardson Pond (SW-316) and the Shaffer Landfill Wetlands (SW-310, SW-311, and SW-313).

Although detected in only five samples (three in June and two in September), chlorinated VOCs were found at locations where aromatic VOCs were detected. The chlorinated VOCs detected in June include: 1,1,2,2-tetrachloroethane (80 μg/kg at SD-022 in Richardson Pond and 80 μg/kg at SD-310 in the Shaffer Landfill Wetlands) and 1,2-DCE (70 μg/kg at SD-309 in Richardson Pond). 1,1,1-Trichloroethane (10 μg/kg at SD-104 in the Middlesex Canal) and chloromethane (14 μg/kg at SD-103 in the Middlesex Canal) were detected in September. Bromomethane, at 44 μg/kg, was also found at SD-103 in September.

Seventeen different PAHs were detected in sediment samples in June and September. Although these PAHs were present both sampling rounds, individual concentrations were generally higher in June. Individual concentrations in June ranged from 17 to 62,000 μg/kg and from 44 to 48,000 μg/kg in September.

The PAHs were found at 39 locations in June and at 27 of these locations and two additional locations in September. Between 1 and 16 PAHs were found in sediment samples collected in June, with total concentrations ranging from 41 to 320,000 μg/kg. Seven or fewer PAHs were detected in 24 samples, while 8 or more were found in 15 samples. Specifically, two sediment locations along the southern edge of Richardson Pond (SD-022 and SD-111) contained between 8 and 13 PAHs with total concentrations of 2,100 μg/kg and 180,000 μg/kg, respectively. Similarly, between 13 and 15 different PAH compounds with total concentrations of 7,400 μg/kg, 320,000 μg/kg, and 5,400 μg/kg were detected at three locations in the unnamed brook (SD-013, SD-118, and SD-322, respectively). Location SD-322 is in the sedimentation pond at the base of an outfall pipe. Two sediment samples collected from the B&M Pond (SD-107 and SD-304) displayed were greater than 12 PAHs at total concentrations of 1,800 and 36,000 μg/kg, respectively, and two locations from the Shaffer Landfill Wetlands (SD-310 and SD-312) had greater than nine PAHs detected with total concentrations of 2,000 and 8,000 μg/kg, respectively. Five locations having 10 or more PAHs include: SD-318 (1,400 μg/kg) which is located near the old salt pile in the B&M Locomotive Shop parking area; SD-102 (2,300 μg/kg) and SD-113 (1,400 μg/kg) in Content Brook; and SD-305 and SD-306 (1,700 μg/kg and 3,100 μg/kg) in the drainage ditch. One additional location, SD-317, from the man-made canal near the B&M Locomotive Shop Disposal Areas, contained 12 PAHs with a total concentration of 19,000 μg/kg.

In comparison to June, between 1 and 17 PAHs at total concentrations ranging from 120 to 230,000 μg/kg were detected in sediment in September. At 14 locations, fewer than 10 PAHs were detected, with concentrations less than 1,400 μg/kg. As in June, between nine and 14 PAHs with total PAH concentrations of 1,400 and 230,000 μg/kg occurred at the same three locations in Richardson Pond (SD-022 and SD-111, respectively). Although a similar number of different PAHs was detected for sediment samples in the unnamed brook (SD-010, SD-013, and SD-322), total PAH concentrations were lower in September than in June, ranging from 1,800 to 6,000 μg/kg. In two of the sediment samples from the B&M Pond (SD-107 and SD-304) more than 11 different PAHs were detected, at total concentrations of 4,200 and 12,000 μg/kg, respectively. More than 12 different PAHs were found at sediment locations SD-310 and SD-312 in the Shaffer Landfill Wetlands and total concentrations were reported as 3,500 and 6,900 μg/kg, respectively. Six additional locations where more than 12 different PAHs were detected include SD-101, SD-102, and SD-113 in Content Brook with total concentrations ranging from 2,500 and 19,000 μg/kg; SD-305 and SD-306 in the drainage ditch with 4,600 and 4,700 μg/kg total concentrations, respectively; and SD-317 in the man-made canal near the B&M Locomotive Shop Disposal Areas with 4,800 μg/kg total concentration. Petroleum hydrocarbons were reported in 29 sediment samples (14 to 3,400 mg/kg) in June and in 25 sediment samples (14 to 2,500 mg/kg) in September. Generally, petroleum hydrocarbons were detected at higher concentrations at sediment locations where PAHs were prevalent.

In addition to PAHs, nine other SVOCs were detected in sediment samples. Found in only one sample, in one or both sampling rounds, were: 1,2-DCB (750 μg/kg at SD-013 in the unnamed brook in June), 1,4-DCB and bis(2-chloroethyl)ether (230 μg/kg and 550 μg/kg, respectively at SD-013 in the unnamed brook in June), and 1,4-DCB (77 μg/kg at SD-312 in the Shaffer Landfill Wetlands in September). During June and September, dibenzofuran was found at 10 locations at concentrations ranging from 35 to 1,600 μg/kg. N-Nitrosodiphenylamine (100 to 300 μg/kg) was detected in one sample in June and three samples in September. 4-Methylphenol was detected during both rounds at concentrations ranging from 50 to 2,900 μg/kg. Two phthalates (BEHP and butylbenzylphthalate) were detected in both sampling rounds at concentrations ranging from 58 to 17,000 μg/kg and 41 to 1,800 μg/kg, respectively. Bis(2-ethylhexyl)phthalate was found in 26 locations in June and two of the same locations in September, while butylbenzylphthalate was found in two locations during June and four in September. Bis(2-ethylhexyl)phthalate was also detected in background sediment samples. Carbazole was detected in both rounds in up to five different sediment samples at concentrations ranging from 31 to 2,300 μg/kg. N-nitrosodiphenylamine was detected in one sediment sample in June (SD-304 in the B&M Pond at 270 μg/kg) and three sediment samples in September (SD-010, SD-013, and SD-322 in the unnamed brook at 300, 100, 146 μg/kg, respectively). These types of organic compounds occurred in samples exhibiting elevated concentrations of other fuel/petroleum-related hydrocarbons. In particular, the PAHs, petroleum hydrocarbons, and associated organic compounds (dibenzofurans, phenolics, di-functional ketones, and carbazole) are indicative of railroad and fuel/petroleum-related products used in industrial activities.

Twenty different pesticides were detected in 44 sediment samples in June. In contrast, seven pesticides were detected in 13 samples in September. More pesticides were detected in June than September and concentrations were generally higher in June than September. Pesticides detected in both June and September include: the DDT group (4,4'-DDE, 4,4'-DDD, and 4,4'-DDT), methoxychlor, dieldrin, endrin, and *alpha*-chlordane. In addition, BHCs (*alpha*-, *beta*-, *gamma*- and *delta*-), heptachlor, heptachlor epoxide, endosulfans (I, II, and sulfate), aldrin, endrins (aldehyde and ketone), and *gamma*-chlordane were detected in June. Individual concentrations were less than 10 μg/kg except for the DDT group (up to 83 μg/kg), methoxychlor (up to 26 μg/kg), dieldrin (up to 17 μg/kg), endrin (up to 15 μg/kg), endrin aldehyde (up to 190 μg/kg), and chlordane (up to 18 μg/kg). DDD and DDE, which are degradation products of DDT, were the most frequently detected pesticides and were generally present in the highest concentration in samples with multiple pesticide compounds. Dieldrin (25 samples), heptachlor epoxide (20 samples), and methoxychlor (14 samples) were the next most frequently detected pesticides in June. Less frequently detected pesticides in June include: chlordanes (11 to 23 samples), endrins (endrin, aldehyde, and ketone; 3 to 18 samples), endosulfan sulfate (6 samples), *delta*-BHC (8 samples), BHCs (*alpha*-, *beta*-, and *gamma*-; up to 4 samples), and heptachlor (1 sample). During September, dieldrin was detected most frequently (5 samples), while methoxychlor, endrin, and chlordanes were detected in a maximum of two samples.

In June, from one to 11 different pesticides were detected in each sample, with between three and nine pesticides identified in 37 samples. Total pesticide concentrations in each sample in June ranged from 0.20 to 350 μg/kg. From one to three pesticides were detected in the 13 samples collected in September. Pesticides were also detected in June in all of the September samples except SD-106. Total concentrations in September ranged from 0.20 to 0.36 μg/kg.

Most notably, the two sediment samples (SD-304 in the B&M Pond and SD-109 located north of Spincraft) with the highest total concentrations (350 μg/kg and 83 μg/kg) had at least six different pesticides detected during June. Other sediment samples with total pesticide concentrations greater than or equal to 30 μg/kg include: SD-315, SD-111, and SD-022 in Richardson Pond (64, 46, and 30 μg/kg, respectively), SD-108 and SD-016 in RSI Wetland Area (61 and 48 μg/kg, respectively), SD-107 in the B&M Pond (33 μg/kg), and SD-307 in the western portion of the Middlesex Canal (32 μg/kg).

In September, total pesticide concentrations greater than 30 μg/kg were found at only two locations: SD-022, a Richardson Pond location, contained pesticides totaling 32 μg/kg and SD-028, located in Middlesex Canal west of Pond Street, contained pesticides totaling 36 μg/kg. Pesticides, similar to those found in site-wide sediments, were also detected in background sediment samples; however background concentrations were generally lower than site-wide sediment concentrations. Site-wide surface water sampled also exhibited similar types of pesticides.

PCBs were detected in sediment samples during both sampling rounds, but were more readily found in June. Six different Aroclors were detected in 29 sediment samples in June, whereas only one Aroclor (1248) was detected in three sediment samples in September. Aroclor 1248 was the most often detected Aroclor in June, occurring in 13 samples and ranging in concentration from 9.1 to 2,000 μg/kg. Generally only one Aroclor was detected in sediment samples during June, with the exception of SD-111, SD-311, and SD-026, where two Aroclors were found. Although only one Aroclor was detected at multiple sediment locations within an area, the type of Aroclor differed.

Other PCBs detected in June include: Aroclor 1016 (2.2 to 4.4 μg/kg), Aroclor 1232 (3.8 to 170 μg/kg), Aroclor 1242 (6.8 to 220 μg/kg), Aroclor 1254 (20 to 320 μg/kg), and Aroclor 1260 (260 to 340 μg/kg). The highest PCB concentration (2,000 μg/kg of Aroclor 1248) was found at

SD-308, which is located at the base of an old discharge pipe originating from the BNZ manufacturing buildings (formerly Johns-Manville).

Other locations where PCBs were detected include: SD-304 in the B&M Pond (Aroclor 1248 at 570 μg/kg), SD-111 in Richardson Pond (220 μg/kg of Aroclor 1242 and 260 μg/kg of Aroclor 1260), SD-313 in the Shaffer Landfill Wetlands (340 μg/kg of Aroclor 1260), and SD-317 in the man-made canal near the B&M Locomotive Shop Disposal Areas (320 μg/kg of Aroclor 1254). In comparison to PCB concentrations in background sediment, the site-wide sediment concentrations for PCBs were 1 to 2 orders of magnitude higher. PCBs were also detected in surface water but in only two locations (SW-308 and SW-111).

The ranges of major metal ion concentrations were similar in June and September: 1,150 to 26,300 mg/kg and 1,160 to 32,300 mg/kg for aluminum; 1,670 to 76,300 mg/kg and 1,580 to 50,200 mg/kg for iron; 307 to 9,700 mg/kg and 173 to 10,500 mg/kg for magnesium; and 303 to 4,600 mg/kg and 277 to 7,400 mg/kg for potassium. Aluminum, iron, and magnesium were detected in all samples during both rounds; however, potassium was reported in only 41 samples during June and only 33 in September.

Calcium and sodium tended to decrease in concentration and frequency of detection from June to September -- 410 to 215,000 mg/kg (in 48 samples) and 532 to 11,100 mg/kg (in 33 samples) for calcium and 1,700 to 13,000 mg/kg (in four samples) and 1,670 to 2,190 mg/kg (in three samples) for sodium.

Concentrations of barium, beryllium, and eight heavy metals were consistent between June and September: 11.9 to 287 mg/kg and 8.2 to 270 mg/kg for barium, 0.80 to 3.7 mg/kg and 0.51 to 3.8 mg/kg for beryllium, 1.6 to 256 mg/kg and 2.8 to 142 mg/kg for arsenic, 1.3 to 3.4 and 0.48 to 5.4 mg/kg for cadmium, 12 to 106 mg/kg and 13.8 to 100 mg/kg for chromium, 3.6 to 2,970 mg/kg and 3.7 to 1,590 mg/kg for lead, 24.4 to 2,700 and 18.3 to 2,750 mg/kg for manganese, 0.06 to 0.99 mg/kg and 0.07 to 1.3 mg/kg for mercury, 13.1 to 132 mg/kg and 14.6 to 52.1 mg/kg for nickel, and 0.61 to 10.2 mg/kg and 0.97 to 7.2 mg/kg for selenium.

In June, seven or more heavy metals were detected in nine sediment locations at total heavy metals concentrations greater than 1,000 mg/kg: SD-304 (2,480 mg/kg), SD-030 (2,460 mg/kg) in the B&M Pond; SD-105 (2,820 mg/kg) in Middlesex Canal; SD-317 (7,410 mg/kg) in the man-made canal; SD-109 (2,170 mg/kg) located north of Spincraft; SD-111 (2,010 mg/kg) in Richardson Pond; SD-301 (1,710 mg/kg) in the RSI Wetlands; and SD-013 (1,970 mg/kg) and SD-118 (1,170 mg/kg) in the unnamed brook. In September, 10 or more heavy metals were detected in six of the same locations, with total concentrations greater than 1,000 mg/kg: SD-317 (4,860 mg/kg), SD-111 (1,810 mg/kg), SD-013 (1,450 mg/kg), SD-118 (2,220 mg/kg), SD-301 (1,670 mg/kd), and SD-310 (1,070 mg/kg).

Concentrations for antimony, cobalt, and vanadium increased between June and September: 4.1 to 26.3 and 3.2 to 158 mg/kg for antimony, 2.3 to 24 mg/kg and 3.2 to 48.6 mg/kg for cobalt, and 5.8 to 76.4 mg/kg and 2.7 to 110 mg/kg for vanadium. Copper and zinc decreased between rounds: 7.6 to 3,600 mg/kg to 6.6 to 2,120 mg/kg for copper and 20.2 to 998 mg/kg and 7.8 to 634 mg/kg for zinc. Silver was detected only in June at five sediment locations (0.83 to 6.7 mg/kg).

In June, cyanide was detected at 1.2 mg/kg in the sample collected from SD-118 (in the unnamed brook) and at 0.89 mg/kg in the sample collected from SD-318 (near the former salt/sand pile). Although SD-318 was not sampled in September, cyanide was not detected at SD-118. Total combustible organic values ranged from 1.1 to 94% in June and from 1.2 to 93% in September (Table 4-25). In comparison, TOC values for a subset of samples that also received TCO analysis ranged from 20,000 to 99,000 mg/kg (2.0 to 9.9%) in June and from 31,500 to 53,000 mg/kg (3.15 to 5.3%) in September. As shown in Table 4-26, TCO and TOC values are relatively comparable for the subset of samples analyzed for both parameters. The grain size distribution in sediment demonstrates that the sediment samples were predominantly composed of sand and silt (94 to 95% and 61 to 79%, respectively).

4.2.4.3 Asbestos Lagoons. Three distinct trenches surrounded by a bermed area (approximately 10 feet above ground surface) were used as Asbestos Lagoons (section 1.2). Until 1985 the unlined lagoons received a 50% liquid asbestos slurry from the adjacent Johns-Manville manufacturing operations (BNZ, 1993). Currently, the lagoons contain solidified asbestos slurry. The two outer lagoons are not covered, although topsoil/fill was used to cover the middle lagoon, creating a make-shift cap. Sparse vegetative cover has grown on the middle lagoon, while the uncovered lagoons are barren of vegetative matter and the surface consists of a dry, white, chalky and fibrous material.

Four samples (SD-323 to SD-326) were collected from the two uncovered lagoons. Samples SD-323 and SD-324 were collected from the northwestern lagoon and SD-325 and SD-326 were collected from the southeastern lagoon. All four samples were collected from the southern end of the lagoons in the area of where the outfall pipes from the manufacturing operations discharged. The samples consisted of a solidified asbestos slurry in the form of a dry, white chalky-fibrous material, similar in texture to plasterboard. The analytes detected in sediment samples from the Asbestos Lagoons are summarized along with site-wide sediment samples in Table 4-25. The predominant types of organic and metals detected are presented in Figures 4-38 through 4-41.

The predominant types of organic compounds that were detected in the Asbestos Lagoons samples were pesticides. In addition, xylene at 120 μg/kg and BEHP at 3,200 μg/kg were detected in SD-324 (located in the northwestern lagoon), while toluene (18 μg/kg) and 2-methylnapthalene (1,500 μg/kg) were detected in SD-326 (located in the southeastern lagoon). No VOCs or SVOCs were reported in the other two lagoon samples, which were closer to the discharge pipes. Petroleum hydrocarbons and PCBs were not found in any of the samples.

Nine different pesticides were detected in the Asbestos Lagoon samples. Concentrations ranged from 0.14 to 1.1 μg/kg for 4,4'-DDE, 0.33 to 0.38 μg/kg for dieldrin, 0.21 to 1.2 μg/kg for endosulfans (I and II), 5.2 to 5.3 μg/kg for endrin, 1.0 to 3.1 μg/kg for heptachlor epoxide, 0.40 to 0.99 μg/kg for BHCs (*alpha-* and *delta-*). Methoxychlor was detected in all four samples and at higher concentrations (3.3 to 7.6 μg/kg) than the other pesticides. Four to seven different pesticides were detected in each sample, with total concentrations ranging from 5.8 μg/kg to 16 μg/kg.

Major metal ions were detected in samples at concentrations ranging from 2,520 to 6,470 mg/kg for aluminum, 186,000 to 215,000 mg/kg for calcium, 3,860 to 9,110 mg/kg for iron, 2,600 to 5,440 mg/kg for magnesium, and 602 to 1,060 mg/kg for potassium. Sodium was detected, but was not reported because of validation qualifications (section 2.3.2). In addition, barium (38.2 to 51.2 mg/kg), manganese (311 to 571 mg/kg), and five other heavy metals were also detected in all samples: arsenic (1.6 to 4.8 mg/kg), copper (8.1 to 15.1 mg/kg), lead (10.6 to 21 mg/kg), vanadium (18.1 to 22.1 mg/kg), and zinc (53.6 to 123.2 mg/kg). Chromium from 12.0 to 18.4 mg/kg and cobalt from 3.4 to 4.2 mg/kg were each detected in three samples. Six to seven heavy metals were found in each sample; manganese accounted for the highest concentrations.

Cyanide was not detected in any of the lagoon sediment samples.

4.2.4.4 Summary of Sediment Contamination. As with surface water, organic compounds and elevated metal concentrations were detected at sediment locations across the Site. Background sediment displayed chemical characteristics similar to those of associated surface water. The primary organic compounds detected in background sediment were PAHs and pesticides, both of which are common to residential and industrialized areas. In addition, the types of heavy metals found at background locations include arsenic, chromium, cobalt, copper, lead, mercury, vanadium, and zinc.

The most prevalent types of organic compounds found in site-wide sediments were PAHs, petroleum hydrocarbons, pesticides, and PCBs. Volatile organic compounds (aromatic and chlorinated) were also commonly found, but less often and in lower concentrations. Aromatic VOCs were more prevalent in June than in September and were found at more locations and at higher concentrations than chlorinated VOCs. Aromatic VOCs (BTEX compounds and chlorobenzene) were detected at 14 sediment locations, most of which are scattered throughout the geographical location groupings, east of Pond Street. Chlorinated VOCs were primarily detected in June at three locations, all of which were east of Pond Street. In contrast, chlorinated VOCs were not present at SD-322, the location within the sedimentation pond where elevated chlorinated VOC concentrations were found at the corresponding surface water location.

In comparison, PAHs and pesticides were more widespread than VOCs, occurring in as many as 44 sediment locations. Like VOCs, PAHs and pesticides tended to be detected more frequently and in higher total concentrations in each location in June compared to September. Multiple PAHs and pesticides were identified at most of the locations. For PAHs, the highest concentrations were usually reported for the larger, more substituted compounds. In addition, petroleum hydrocarbons and other fuel/petroleum-related combustion compounds (e.g., dibenzofuran, phenolics, carbazole) generally occurred at sediment locations where PAHs were prevalent. For pesticides, the DDT group was detected more frequently and at higher concentrations than other pesticides. Of the 20 pesticides identified in June, only seven were reported in September. Both PAHs and pesticides were also present in background sediment locations.

Although PCBs were not as widespread as PAHs and pesticides, as many as six Aroclors were identified at 29 sediment locations in June. In comparison, one Aroclor (1248) was found at three of the 29 locations in September. The highest concentrations occurred at the four sediment locations in the northern portion of the Middlesex Canal, which is east of Pond Street and directly north of the asbestos lagoons. PCB contamination in this portion of the canal, as well as in the stormwater drain system, wells, and soils in the vicinity of the canal and the BNZ facilities that are south of the asbestos lagoons, has been historically documented since 1986 (CDM, 1987 and GZA, 1987). A summary of the PCB contamination in this area is summarized in the PCB Contamination Report (M&E, 1994b) presented in Appendix A. Although PCB-contaminated sludge and sediment from the stormwater catch basins was removed in 1986 (GZA, 1987), current findings indicate that sediments in this section of the canal still remain contaminated, with individual Aroclor concentrations as high as 2,000 μg/kg. Additionally, PCBs were found in June at one location within four other geographical groupings: B&M Pond, Richardson Pond, Shaffer Landfill Wetlands, and the man-made canal near the B&M Locomotive Shop Disposal Areas.

In addition to major metal ions, beryllium, barium, manganese, and 13 other heavy metals were detected in sediments across the Site. There were no apparent distribution patterns. Arsenic, lead, and zinc were among the heavy metals detected most often and at more elevated concentrations than those found in the background sediments.

The sediments in the Asbestos Lagoons exhibited different chemical characteristics. The three unlined trenches located on BNZ property were used until 1985 for the disposal of a 50% liquid asbestos slurry from the Johns-Manville manufacturing operations. Currently, the solidified asbestos slurry is exposed in the two end lagoons. The central lagoon is covered with topsoil/fill and sparse vegetation. The samples collected from the lagoons consisted of a solidified asbestos slurry in the form of a dry, white chalky-fibrous material. No other waste material, staining, or discoloration was observed in the lagoons.

A few organic compounds including two VOCs, one phthalate, and one PAH were each detected once. In comparison, several pesticides were detected at the four sampling locations. Since the samples collected represent surficial conditions and pesticides are not associated with the manufacturing operations, the presence of pesticides have likely resulted from large-scale spraying of the general area.

Metal concentrations were generally similar between individual samples from the Asbestos Lagoons. While several heavy metals were present, calcium concentrations were substantially elevated in comparison to other metals. This is attributed to the fact that calcium-enriched minerals are typically major components of plasterboard.

4.2.5 MCL Evaluation

Concentrations for analytes detected in groundwater and surface water at the Site are compared in this section to Maximum Contaminant Levels (MCLs) promulgated under the Safe Drinking Water Act. The comparison is included because MCLs are widely known benchmarks for water contamination; the comparisons give an overall view of the level of contamination in groundwater and surface water at the Site. Neither groundwater or surface water is used as a source of drinking water at the Site and MCLs are not strictly risk-based. Therefore, the comparison to MCLs should not be construed as describing Site risks.

4.2.5.1 Comparison of Groundwater to MCLs. Groundwater concentrations are compared to Safe Drinking Water Act MCLs in Tables 4-27 through 4-31 to give a general impression of the level of contamination in Site groundwater. Exceedances of MCLs by groundwater were infrequent. Several analytes exceeded MCLs in groundwater at one or more locations in March/April and/or July 1995. No MCLs were exceeded in groundwater samples from the Oil/Sludge Recycling Area. Among metals, arsenic exceeded MCLs in one or more wells at the B&M Railroad Landfill and the RSI Landfill. Lead exceeded the tap water action level in one or more wells at the Asbestos Lagoon, B&M Railroad Landfill, and the RSI Landfill. Nickel exceeded the MCL in one well at the Asbestos Lagoon. The MCL for thallium was exceeded in one well at the RSI Landfill.

Among organic compounds, the MCL for 1,2-DCA was exceeded in one well (MW-209B) at the asbestos lagoon, and in multiple wells at the B&M railroad landfill. The MCL for 1,2-DCE was exceeded in multiple wells at the B&M Railroad Landfill. The benzene MCL was exceeded once at the RSI landfill. The MCL for BEHP was exceeded once, in a well from the B&M Railroad Landfill. The MCL for TCE was exceeded in multiple wells at the B&M Railroad Landfill and in one well at the RSI Landfill.

There was reasonably good comparison between rounds for the location of the maximum exceedance of an MCL. This is evidence of reproducibility of results. Among metals, the comparison to MCLs does not distinguish significant groundwater contamination from high turbidity. Among organic compounds, exceedance of MCLs at the Site appears to be a good indication of real contamination. By this measure, groundwater contamination with organic compounds was found at three of the areas of concern: the Asbestos Lagoon, B&M Railroad Landfill, and RSI Landfill.

4.2.5.2 Comparison of Surface Water to MCLs. Surface water concentrations are compared to Safe Drinking Water Act MCLs in Table 4-32 to give a general impression of the level of contamination in site-wide surface water. Several analytes exceeded MCLs in surface water at one or more locations in June and/or September 1993. With three exceptions, analytes that exceeded MCLs were limited to metals. The tap water action level for lead (15 μg/l, used here for comparison in the absence of an MCL) was exceeded in the most samples (26 of 84 plus some background samples). Other metals exceeded their MCLs in 15% or less of site-wide surface water samples. These metals consist of antimony, arsenic, barium, beryllium, cadmium, chromium, and thallium. Overall, metal exceedances were not limited to any one location. Except for arsenic (at SW-030), locations of the maximum concentration of metals exceeding MCLs were not consistent between June and September sampling.

Concentrations of methylene chloride, PCE, and TCE exceeded MCLs in one or two samples each. The MCL for each of these VOCs is 5 μg/l. Site concentrations that exceeded MCLs ranged from 8 μg/l to 16 μg/l. The exceedances of the MCLs for PCE and TCE (two each) occurred only at sample location SW-322, which is situated in a sedimentation pond directly connected to the unnamed brook.

To the extent that exceedances of MCLs indicate contamination, metals contamination in surface water is widespread and contamination with organic compounds is localized. However, the variability in metals results suggest that the results may not be reproducible. The limited extent of organics contamination in surface water suggests a discrete source; the VOCs likely disperse from this point.

SECTION 5.0
CONTAMINANT FATE AND TRANSPORT

The nature and extent of potential contaminants detected in different media at the areas of concern within the Iron Horse Park Superfund Site are discussed in section 4.2. The extent to which these contaminants have migrated and the expected fate of future migration depend on three principal factors:

- Physical and chemical properties of the contaminants
- Transport processes
- Properties of the media through which the contaminants migrate

These factors control dominant transport pathways and migration rates of chemicals through different environmental media. For example, the interaction between chemicals and the different media may be affected by the physical adsorption of a contaminant onto soil particles or the chemical reactions between soils, the contaminant, and water. Following a summary of the principal contaminants at the site study area, the predominant transport processes are identified in the following sections.

5.1 SITE CONTAMINANTS

More than 126 analytes that are potential contaminants, including both organic and inorganic analytes, were detected on the Site in surface and subsurface soils, groundwater, surface water, and sediments. Chemicals were detected in all media, with the highest concentrations generally within and downgradient of the various areas of concern. Chemicals detected above expected background concentrations are considered to be contaminants.

The chemicals detected in all media can be separated into different groups based on physical and chemical characteristics. The groups consist of VOCs, which can be further broken down into the subgroups aromatics, halogenated, and ketones; SVOCs, which include the subgroups PAHs, phthalates, and phenolics; pesticides; PCBs; petroleum hydrocarbons; metals; and other inorganic compounds. Section 5.2 focuses on the physical and chemical properties of these different groups and discusses how these properties affect potential transport processes.

5.2 PHYSICAL AND CHEMICAL PROPERTIES OF THE CONTAMINANTS DETECTED

Physical and chemical properties of a contaminant partially influence its behavior in different media. An understanding of these properties helps predict how the contaminant will move (or partition) from one medium into another (e.g., soils into water, groundwater into air). The extent to which a contaminant moves or is transported through the environment is often referred to as mobility. A chemical with high mobility is one that is easily released from a waste source or soils into groundwater, where it can be transported into a surface water body and then volatilized into air. A chemical that remains strongly adsorbed onto soil particles is considered to have low mobility. In part, the ability of a contaminant to be transported through various media is based on the many types of chemical and physical interactions of that contaminant with the media. Examples of the types of interactions or processes that influence the transport of a chemical are hydrolysis, volatilization, adsorption, ion exchange and photolysis. In addition, chemicals undergo different degrees of degradation. Physical and chemical properties of the contaminant affecting these interactions include, but are not limited to, water solubility, partition coefficients, and chemical structure.

This section describes the physical and chemical properties of the different chemical groups of contaminants and the relationship of these properties to the environmental transport processes and persistence of the various chemicals. Physical and chemical properties for organic chemicals and cyanide are presented in Table 5-1. Physical and chemical properties for metals are presented in Table 5-2. Each of the properties provides some guidance regarding the expected behavior of the contaminant in a given environment. Only physical state and solubility information are shown for metals, because each metal may possess a variety of different forms (e.g., salts and inorganic and organic complexes) with widely varying physical and chemical properties.

The water solubility of a chemical is defined as the maximum concentration of that chemical that will dissolve in pure water at a specific temperature and pH. The water solubilities of most common organic chemicals range between 1 and 100,000 mg/l (Lyman, et al., 1982). Highly soluble chemicals can be rapidly leached from wastes or contaminated soils and are generally easily transported in water.

Vapor pressure and Henry's Law constant are two measures of chemical volatility. Vapor pressure is a measure of the volatility of a chemical from its pure state at a specific temperature. The vapor pressures of liquids typically range from 0.001 to 760 mm Hg. A higher vapor pressure indicates a greater tendency for movement of a chemical into air. A vapor pressure greater than 1 mm Hg is usually characteristic of chemicals having high volatility, whereas a vapor pressure less than 0.01 is characteristic of chemicals with low or very limited volatility.

Henry's Law constant (K_h) considers the interaction between water solubility and vapor pressure and is an important predictor of a chemical's volatilization from water to air. A large Henry's Law constant (i.e., greater than 1×10^{-3} atm-m^3/mole) indicates a tendency for a chemical to readily move from water into air.

The octanol/water partition coefficient (K_{ow}) represents the distribution of a chemical between octanol and water phases under equilibrium conditions. Octanol/water partition coefficients are usually reported in logarithmic form and represent the tendency of a chemical to move between water and organic material, such as soil or fish tissue, or organic phases, such as nonaqueous-phase liquids. Chemicals with a low log K_{ow} value (i.e., less than 1) tend to remain dissolved in water rather than adsorb onto an organic material and are classified as hydrophilic compounds. Chemicals with a high log K_{ow} value (i.e., greater than 4) are more likely to remain adsorbed to organic material rather than migrate to water. These chemicals are considered hydrophobic (Lyman et al., 1982).

The organic carbon partition coefficient (K_{oc}) indicates the tendency of an organic chemical to be adsorbed to organic material in soils or sediments. The K_{oc} is independent of soil properties. The capacity for a chemical to be adsorbed is a function of the K_{oc} and is directly dependent on the percentage of organic carbon in the soil. A low value indicates that a chemical can easily be leached (desorbed) from soil or sediment to water. A high K_{oc} value indicates that a chemical has a strong affinity to bind to organic material in soil. A chemical with a high K_{oc} value may be of great concern if it is detected in water, since it usually indicates a tendency to bioaccumulate. The typical range of K_{oc} values for organic chemicals is from 1 to 1×10^7 ml/g (Lyman, et al., 1982). Values of K_{oc} greater than 1,000 ml/g generally indicate chemicals with greater adsorption potential. A K_{oc} value between 100 and 1,000 ml/g is considered intermediate, while a K_{oc} value less than 100 ml/g indicates a low adsorption capability.

Mobility of dissolved chemical compounds in groundwater systems is often quantified by the distribution coefficient:

$$K_d = f_{oc} \times K_{oc}$$

Where:

K_d = distribution coefficient, ml/g

f_{oc} = fraction of organic carbon, g/g

K_{oc} = carbon partition coefficient, ml/g

The distribution coefficient represents the partitioning between liquids and solids (transfer by adsorption) assuming that the relationship is linear and reversible (a valid assumption for groundwater studies). Compounds with K_d values that are orders of magnitude greater than 1 ml/g can be considered essentially immobile (Freeze and Cherry, 1979). To compare mobility of groups of chemicals, K_d values were calculated for the most conservative compounds (most mobile) for each group of organic compounds found in groundwater within the Site, using average values of the fraction of organic carbon or content (f_{oc}; measured as total combustible organics) for borehole soils and values of K_{oc} found in literature. The calculated K_d values are shown below.

Compound Group	f_{oc} (g/g)	K_{oc} (ml/g)	K_d (ml/g)
PCBs	0.081	$5.3x10^5$	$4.3x10^4$
Pesticides (DDT)	0.081	$2.4x10^5$	$1.9x10^4$
SVOCs (PAHs: Naphthalene)	0.081	$1.3x10^3$	$1.1x10^2$
SVOCs (Phthalates: Bis (2-ethylhexyl))	0.081	$5.9x10^3$	$4.8x10^2$
VOCs (Chlorinateds: TCE)	0.081	$1.3x10^2$	$1.1x10^1$
VOCs (Ketones: acetone)	0.081	2.2	$1.8x10^{-1}$
VOCs (Aromatics: Benzene)	0.081	$8.3x10^1$	$6.7x10^0$

As shown above, most PCBs, pesticides, PAHs, and phthalates can be considered immobile in the dissolved phase, whereas VOCs are more mobile than other classes of organic compounds.

The K_d is also applicable to metals. However, for metals, in contrast to organic compounds, it accounts for sorptive processes on soils (e.g., cation exchange, exchange with surface ligands, organic complexation), which are not directly a function of organic carbon content. This parameter is typically measured in the laboratory for a particular metal on a soil from a particular site. No values are available for this Site. Therefore, unlike the coefficient for organic compounds, the distribution coefficient for metals cannot be used to quantify migration.

Density, or mass per unit volume, is a physical parameter that controls the rate of contaminant movement in the subsurface. In natural waters, density and specific gravity are approximately equivalent. If the density of the contaminant is greater than that of water (i.e., greater than 1 g/cm^3), the contaminant will tend to displace groundwater and sink until a horizontal, less permeable barrier is encountered. It will move horizontally along the barrier in the direction of maximum slope. A density less than that of water (i.e., less than 1 g/cm^3) will cause the contaminant to float on the groundwater surface and move horizontally downgradient along the water surface.

The following sections describe how these properties help in characterizing the tendency of the contaminants of concern to be transported through or be retained in specific media on the Site.

5.2.1 Volatile Organic Compounds

In general, VOCs are characterized by high vapor pressures and K_H values and moderate to low K_{ow} and K_{oc} values. As a result, these chemicals tend to be very mobile in the environment. Volatile organic compounds were detected in each of the areas of concern within the Site. The VOCs discussed in this section were subgrouped together based on their similar chemical and physical properties. However, some organic compounds have properties similar to those of more than one subgroup, particularly chlorobenzene, 1,2-DCB, and 1,4-DCB. These three compounds are both aromatic and halogenated VOCs. Furthermore, 1,2- and 1,4-DCB are also considered SVOCs, although they are analyzed with VOCs in several EPA analytical methods. In the following text, chlorobenzene, 1,2- and 1,4-DCB have been grouped along with the aromatic VOCs. Additionally, isophorone, a semivolatile organic ketone, has been grouped with the volatile ketone compounds.

5.2.1.1 Halogenated Volatile Organic Compounds. Halogenated is a term that describes branched or straight-chained alkanes, alkenes, and alkynes that are halogenated. Halogens are a group of chemically related elements that include fluorine, chlorine, bromine, iodine, and astatine. All of the halogenated VOCs detected at the Site were chlorinated compounds. Halogenated VOCs detected include chloroform; 1,1- and 1,2-DCA; 1,1-DCE; *cis*- and *trans*-1,2-DCE, methylene chloride, 1,1,1-TCA, TCE, 1,1,2,2-PCA, and PCE.

When released to soils, these compounds have more of a tendency to leach to groundwater than to adsorb to soil particles because of low K_{oc} values and high water solubilities. Volatilization from soils, particularly surface or shallow soils, also occurs rapidly because of high vapor pressures and can be a primary removal mechanism from this medium.

Once in groundwater or surface water, halogenated VOCs are relatively mobile because of low K_{oc} and K_{ow} values. A major mechanism for removal of these compounds from groundwater and surface waters is volatilization to the atmosphere, as indicated by high K_H values. Adsorption to sediments does not readily occur. Upon release to the atmosphere, the halogenated VOCs preferentially exist in the vapor phase.

Halogenated VOCs do not readily degrade in the atmosphere. Tetrachloroethene and TCE will degrade slowly in soil and water, although this is not considered a significant removal mechanism (Howard, 1990b). The predominant chemicals formed during the degradation of TCE are 1,2-DCE (*cis* and *trans* isomers) and vinyl chloride. In general, these partially dechlorinated compounds are relatively resistant to degradation processes (Howard, 1990b; ATSDR, 1987 to 1993).

All of the halogenated VOCs are denser than water with the exception of chloroethane. If these compounds are released to the environment in a concentrated form, they may migrate vertically through a saturated medium as a separate phase. In this form, these compounds are referred to as DNAPLs (dense non-aqueous phase liquids). Although DNAPLs were not observed in any of the areas of concern, there is still a possibility that these separate phases could be present at the Site.

5.2.1.2 Aromatic Volatile Organic Compounds. This group of compounds includes BTEX (benzene, toluene, ethylbenzene, and xylene) compounds in addition to chlorobenzene, styrene, 1,2-DCB and 1,4-DCB. Collectively, aromatic VOCs possess similar physical and chemical properties, which influence their fate and transport throughout natural environments.

In soils, aromatic VOCs have a strong tendency to leach into groundwater or surface water because of relatively high water solubilities. Volatilization from dry or wet soils is a major removal mechanism, especially from shallow soils, because of high vapor pressures and K_H values. A combination of high K_{ow} values and moderate K_{oc} values causes the aromatic VOCs to readsorb to soils and sediments while dissolved in water. When in contact with soils, aromatic VOCs may adsorb to the soil surface. The degree of adsorption is primarily dependent on the organic content of the soils. Since the aromatic VOCs have moderate K_{oc} values, higher organic content provides favorable conditions under which these compounds can adsorb to the soils.

In subsurface soils and water, degradation is an important removal process. The rates of degradation in the atmosphere and in water and soil systems depends on many variables, including microbial populations, temperature, moisture, and oxygen concentration. Aromatics VOCs are relatively resistant to hydrolysis (Howard, 1990b).

The nonchlorinated aromatic VOCs (e.g., BTEX compounds) have densities less than water, while the chlorinated VOCs (chlorobenzene; 1,2-DCB; and 1,4-DCB) have densities greater than water. As saturation is reached by these chemicals in aqueous systems, or if released in concentrated solutions, the nonchlorinated VOCs, which are lighter than water, will tend to float to the top of the water table and can form a floating product layer, referred to as a LNAPL (light non-aqueous phase liquid). The chlorinated VOCs are heavier than water and will tend to sink down through the groundwater until they reach a less permeable layer. At concentrated solutions they will form a sinking product layer, referred to as a DNAPL (dense non-aqueous phase liquid). When groundwater comes into contact with the concentrated solutions, dissolution and leaching of the aromatic VOCs occur until saturation in groundwater is reached or exceeded.

Nonchlorinated aromatic VOCs were detected in all media on the Site. In groundwater, these compounds tended to be found in the shallow overburden rather than the deep overburden or bedrock, since they are less dense than water. The chlorinated aromatic VOCs were detected more frequently in the deep overburden and bedrock flow zones than in the shallow overburden since they are denser than water and migrate downward in groundwater.

5.2.1.3 Ketones. Acetone, MEK, 2-hexanone, MIBK, and isophorone are included in this group. Acetone is a degradation product of isopropanol (IPA) and is also produced by microorganisms under anaerobic conditions. In the absence of water, ketones are easily volatilized from soils into air due to high vapor pressures. Ketones are mobile in water systems because of high water solubilities and low K_{oc} and K_{ow} values. As suggested by low K_H values, these compounds preferentially remain in water systems; however, volatilization is considered the major mechanism of release. Adsorption to sediments or soils from water is unlikely between low K_{oc} values. Ketones biodegrade in water and soil over long periods of time.

Ketones were found in most media on the Site, with acetone being one of the most prevalently detected compounds. However, as discussed in Section 2.3.2, a closer review of laboratory reports indicates that the ketones detected in soil, surface water, and sediments are likely laboratory artifacts and are not site related.

5.2.1.4 Volatile Gases. Volatile gases detected at the Site include bromomethane and chloromethane, chloroethane, and vinyl chloride. As indicated by their chemical grouping, volatile gases preferentially exist in a vapor or gaseous phase under normal environmental conditions. When released to soil these compounds rapidly volatilize based on their high vapor pressures and preference to return to a gaseous state. Volatile gases are also highly soluble in water. If the soil is in contact with water, these gaseous compounds will easily leach into water. Although the volatile gases are highly soluble, they have high K_H values and rapidly volatilize back to a vapor phase. As a result, adsorption to soil does not readily occur. Under typical environmental conditions, vinyl chloride and chloroethane are not readily biodegraded.

5.2.1.5 Carbon Disulfide. Carbon disulfide is a product of anaerobic biodegradation of municipal waste and sludges (Howard, 1990a) and occurs naturally under reducing conditions in the environment. As suggested by high water solubilities and low values for K_{oc} and K_{ow}, carbon disulfide tends to volatilize quickly from soils and waters to the atmosphere. Carbon disulfide leached to groundwater will tend to biodegrade readily (Howard, 1990a). Carbon disulfide was detected in several media across the Site.

5.2.2 Semivolatile Organic Compounds

High K_{oc} and K_{ow} values coupled with low vapor pressures and K_H values indicate the tendency of SVOCs to be relatively immobile and very persistent in the environment. For the most part, when released to water or soil systems, the transport of these compounds is primarily governed by adsorption to soil and sediment, particularly to those high in organic materials. At the Site, SVOCs were found in low concentrations in groundwater due to their strong adsorption to soil and low solubility, but they were detected at high concentrations in the soil in some areas of concern.

5.2.2.1 PAHs. A total of eighteen different PAHs, with 2- to 6-ring structures, were detected in different media across the site. In contrast to VOCs, PAHs strongly adsorb to soils, sediments, and organic materials because of large values for K_{oc} ; therefore, they are not mobile in water systems. Because the smaller-ring PAHs (such as naphthalenes) have moderate K_{oc} values, they are slightly soluble in water and may volatilize from water to air to a limited extent. As the number of aromatic rings in the chemical structure of PAHs increases, the affinity for adsorbing to soils and organic materials increases, and solubility and volatilization decrease. In addition, the extent to which PAHs adsorb to soils largely depends upon the organic content of the soils. These properties are related to increasing K_{oc} and K_{ow} values coupled with decreasing vapor pressures and K_H values in aqueous systems.

The major mechanism for the removal of PAHs is biodegradation of larger-ring PAHs in waters and soil, although this process is slow. Degradation of all PAHs in water by photolysis and chemical oxidation is also an important removal mechanism (ATSDR, 1990j). PAHs comprise a large fraction of creosote (typically around 85%). Data from studies of creosote sites suggest that concentrations of PAHs decrease significantly with distance from a creosote source (Kiilerich and Arvin, 1996). The reasons cited include biodegradation and strong adsorption.

5.2.2.2 Phthalates. This group of compounds includes BEHP, butylbenzylphthalate, di-n-butlyphthalate, di-n-octylphthalate, and diethylphthalate. Upon release to the environment, these compounds will strongly adsorb to soils. Because of high K_{oc} and K_{ow} values and low water solubilities, phthalates are not readily leached to groundwater or surface water. Low vapor pressures indicate that volatilization from soils is not generally significant, although studies have shown that diethlyphthalate has the potential to volatilize from dry surfaces (Howard, 1990a). When present in groundwater or surface water, the major removal mechanism is adsorption to soils or sediments. Low K_H values indicate that volatilization from water systems is minimal. Phthalates usually biodegrade quickly in waters and soils in the presence of oxygen. Hydrolysis and photodegradation are not considered typical fates for these chemicals.

5.2.2.3 Phenolics. Included in this group are 4-chloro-3-methylphenol; 2,4-dimethylphenol; 2- and 4-methylphenol; pentachlorophenol; and phenol. As indicated by low K_{oc} values and high water solubilities, these compounds will leach to groundwater or surface waters from soils. Volatilization from soils and water is minimal because of low vapor pressures and low K_H values. Phenolics biodegrade quickly in soil and water systems under both aerobic and anaerobic conditions to form simple aliphatic alcohol and carboxylic compounds. Phenolics are typically a component of creosote wastes.

5.2.2.4 Other Semivolatile Organic Compounds. The remainder of SVOCs that were occasionally detected at the Site but do not fall within the above chemical groupings include 3-nitroanaline, carbozole, N-nitrosodiphenylamine, dibenzofuran, and bis(2-chloroethyl)ether. Collectively, these miscellaneous compounds will behave relatively similar to other SVOC compounds, though they may possess certain physical or chemical characteristics that may facilitate slightly different behavior in environmental media.

5.2.3 Petroleum Hydrocarbons

Petroleum hydrocarbons defines a group of hydrocarbons that are components of common petroleum products, including fuels, tars, and creosote. The analytical method that is used to quantitate the hydrocarbon concentration does not differentiate between individual hydrocarbon compounds, but provides a measurement of total concentration. The types of hydrocarbons included in this group range from aromatic VOCs to PAHs to long-chained (straight, branched, and cyclic) hydrocarbons, typically ranging in number of carbons from C_2 to C_{50} As a result, individual compounds within this group display a large range of physical and chemical properties, and therefore different behaviors and interactions in environmental situations. But collectively, the environmental behavior of most petroleum hydrocarbon compounds is similar. In general, petroleum hydrocarbons readily absorb to soil. Some components may be more soluble and volatile than others, typically resulting in differential leaching and mobility in the environment.

At this Site, petroleum hydrocarbons are abundant in soils and sediment, particularly those associated with past railroad-related activities (B&M Railroad Landfill, Old B&M Oil/Sludge Recycling Area, etc). In many cases, the detection of petroleum hydrocarbons coincides with the detection of PAHs, as well as the detection of phenolic compounds and aromatic VOCs. Given the inherent nature of past railroad operations, the petroleum hydrocarbons detected at this Site are probably indicative of fuels, oils, coal tar, and creosote products, as well as combustion products from the burning of fuels and oils, and in the case of the RSI Landfill, the burnt refuse and municipal wastes.

5.2.4 Pesticides

Chemical and physical properties of pesticides contribute to the mobility and persistence of these compounds in different environmental media. Included in this group are all of the 21 pesticides detected at the Site: the DDT group (DDT, DDD, and DDE), aldrin, dieldrin, endosulfans, endrins, heptachlors, methoxychlor, BHCs, and chlordanes. In general, most pesticides are strongly adsorbed to soils and sediments (i.e., have high K_{ow} and K_{oc} values). Biodegradation and volatilization from soils and water can be significant fate mechanisms.

Pesticides were found in all media on the Site and at background sample locations indicating the ubiquitous nature of these compounds in this area.

5.2.5 PCBs

PCBs have been detected at the Site, particularly in subsurface soils and sediments. Collectively, PCBs possess a variety of physical and chemical properties that influence their fate and transport throughout natural environments. In general, PCBs are persistent in the environment and are characterized by low water solubilities, low vapor pressures, low K_H values, and high K_{oc} values.

The physical and chemical properties of specific PCB Aroclors and Aroclor mixtures depend on the extent of chlorination and the positions of chlorine atoms around the biphenyl ring structure. Aroclors with a small degree of chlorination generally tend to be less persistent and more mobile in the environment than heavily chlorinated Aroclors.

The ability of PCBs to degrade within natural environments also depends on the degree of chlorination. Because PCBs do not readily react with other chemicals, they are considered to be inert and are expected to persist in the environment. Several Aroclors were detected in all media on the Site except surface soil.

PCBs may exist as a DNAPL (e.g., PCB oils) as a result of disposal of hydraulic oils, or may be dissolved in other DNAPL mixtures containing solvents. In a DNAPL form, PCBs may exist deeper in groundwater systems than would be expected under dissolved plume migration.

5.2.6 Non-Aqueous Phase Liquids

Non-aqueous phase liquids (NAPLs) are individual or mixtures of organic compounds that exist as a separate liquid phase in aqueous systems. The DNAPLs are NAPLs that are denser than water (densities greater than 1.0 g/cm^3) and therefore tend to sink in aqueous systems. The LNAPLs are NAPLs that are less dense than water (densities less than 1.0 g/cm^3) and therefore tend to float in aqueous systems.

Concentrations of organic compounds in groundwater greater than approximately 1% of the water solubility of the compound are generally considered to indicate the presence of NAPL (U.S. EPA, 1992e). In the case of a mixture of chemicals, if an individual compound's concentration in groundwater is 1% of its effective solubility (determined based on the mole fraction of the compound in the mixture), it is indicative of the presence of NAPL.

Examples of DNAPLs that may exist at the Site, as evidenced by detections of potential DNAPL compounds in soil and groundwater, include chlorinated solvents (e.g., TCE, 1,1 TCA), PCB oils, and creosote. Examples of LNAPLs include waste oils and fuel oils.

Based on disposal history, it is likely that some organic compounds found in the various areas within the Site were disposed of in a pure liquid form. This is substantiated by observations of NAPL phases in the form of floating product (Old B&M Oil /Sludge Recycling Area) and oily sands (Old B&M Oil /Sludge Recycling Area and B&M Railroad Landfill).

If the liquid chemical is denser than water and has a finite interfacial tension (not readily miscible with water), and if it is present in sufficient volume, it will migrate as a DNAPL downward through the unsaturated and saturated zones until a capillary barrier (low permeability layer) is encountered, where it will pool (Pankow and Cherry, 1996). This form of DNAPL is considered to be mobile. The depth of migration will depend on the volume of DNAPL released, the mass transfer rate, the bulk retention capacity of the soil, and the location of capillary barriers. As DNAPL flows through the unsaturated zone, mass transfer to the air and water will diminish its volume and will reduce the rate of flow and depth of penetration. In the case of chlorinated solvents, this mass transfer could substantially reduce their volume. In the unsaturated zone, mass transfer from DNAPL to the soil gas could be the most significant phase transfer mechanism for chlorinated solvents. In the case of PCB oils, however, very little mass transfer will occur due to the low solubility and vapor pressure. If small volumes were disposed of (e.g., in 55-gallon drums), as is likely the case within several areas of concern at this Site, the forces driving the DNAPL dissipate, and the DNAPL in the pore openings become disconnected to form a zone of residual DNAPL. This is considered the immobile form of DNAPL.

At this Site, there are several instances where chlorinated solvents, PAHS, and PCBs were detected in deep overburden and bedrock groundwater flow zones (i.e., below the limits of fill materials). These findings may be further evidence of DNAPL. However, because groundwater data for the Site generally show low concentrations of these compounds in the vicinity and downgradient of areas of concern, it is likely that DNAPL is not widespread. The DNAPLs that are present in mobile or immobile form will slowly dissolve over time and possibly contribute to a dissolved phase plume.

Soil and groundwater data indicate elevated concentrations of PAHs, phenolics, aromatic VOCs, and petroleum hydrocarbons, which could be indicative of coal tar, creosote wastes, fuel and oil wastes. In contrast to chlorinated solvents, these wastes and/or waste mixtures typically are slightly denser than water and have very high viscosities. Consequently, they are not as mobile as the denser, less viscous chlorinated DNAPLs. In addition, data from studies of creosote sites suggest that concentrations of creosote compounds in a dissolved phase tail off significantly within 50 meters of a creosote source due to various processes such as adsorption, dispersion, and/or biological and abiotic degradation (Kiilerich and Arvin, 1996). Thus, dissolved-phase plumes derived from creosote and other petroleum-related DNAPLs are not expected to be large.

At industrial sites, DNAPLs often contain mixtures of chemicals because either a variety of chemicals are disposed of in a particular disposal area and/or chemicals are mixed and then disposed of in an area. Cosolvation of DNAPL compounds within the environment could also occur. DNAPLs containing a mixture of chemicals are referred to as multicomponent DNAPLs. In water systems, components of a DNAPL mixture dissolve away preferentially according to their relative solubilities. For example, in a DNAPL mixture containing chlorinated solvents and PCBs, the solvents will dissolve away first, followed by PCBs because PCBs have lower solubility. The mixing and cosolvation of chemicals in the environment may increase mobility of chemicals that would be expected to be immobile in water systems.

LNAPLs are not as great a concern with regard to migration because they do not penetrate for below the water table and because most chemicals in LNAPLs are prone to degradation and volatilization (Pankow and Cherry, 1996). Thus plume sizes are typically smaller than soluble DNAPL plumes.

5.2.7 Metals

Assessing the mobility of metals in environmental media is complicated because of the many organic and inorganic complexes and salts they form. In addition, metals undergo a variety of processes in soils and water, which include hydrolysis, reduction, oxidation, and adsorption (i.e., ion exchange, specific adsorption). These reactions are highly dependent on factors such as pH, salinity, ionic strength, particle-surface reactions, and the presence of anions and natural organic acids (humics and fulvics). Many of the metals of concern at the Site are expected to be relatively insoluble, either in metallic form or as inorganic complexes and salts, but may become soluble in the presence of organic acids and oxidizing conditions. An exception is mercury, which is not very soluble in water but will readily volatilize from water to air. Adsorption of metals through cation exchange, specific adsorption, co-precipitation, or organic complexation by soils and sediments is the dominant fate mechanism in natural systems. Metals vary in the extent to which they are adsorbed by these mechanisms, and the adsorbents range in selectivity for metals. For example, the selectivity of peat for divalent metals is as follows: lead>copper>cadmium=zinc>calcium (Alloway, 1990).

Elemental iron and various complexes are insoluble in water and tend to partition into sediments. The pure metal is very chemically reactive and, in the presence of oxygen and moisture, forms iron hydroxide. In the environment, the common valence states of iron (Fe) are Fe^{2+} and Fe^{3+}. Under reducing conditions, iron is predominantly present in aqueous systems as Fe^{2+}, and, in oxidizing conditions, Fe^{3+} is the dominant species. Fe^{2+} is less mobile than Fe^{3+} and tends to form complexes with ligands and anions. This complexing causes precipitation. The solubility is pH dependent. In water samples, iron may be present in true solution, colloidal state, organic or inorganic complexes, or suspended particulate. Groundwaters that contain elevated levels of iron are usually low in dissolved oxygen and high in carbon dioxide. The mobility of iron from soils is relatively low under neutral pH conditions.

In comparison, cations such as barium and manganese are mobile in natural environments. These cations are easily leached from salts and minerals to water systems due to weathering processes.

In water, these cations are dissociated to ionic forms, which tend to remain mobile unless affected by changes in pH or other interactions, such as retention by soils through cation exchange reactions.

Metals occur naturally in soil, groundwater, and surface water systems as a result of weathering of rocks and soils and decay of plants. However, concentrations are often elevated in industrial settings. Common sources of heavy metals are atmospheric pollution from motor vehicles, fuel combustion products (e.g., ash, slag), industrial sludges and wastewaters (Alloway,1990). These are all potential sources of metals at the Site, and can explain the elevated concentrations of metals at the Site. Conclusions regarding the migration of metals are difficult to make due to the numerous reactions and complex geochemistry discussed above. Therefore, the discussion of metals migration in the remainder of this section is limited to identifying locations and trends in metals concentrations.

5.2.8 Other Inorganic Compounds

Cyanide was analyzed for in all media, while anions (Cl, NO_3/NO_2, SO_4, and P) were analyzed only in groundwater.

5.2.8.1 Cyanide. Evaluating the mobility and persistence of cyanide in the environment is as difficult and complex as it is for metals because cyanide can take many different forms. The form in which cyanide exists is highly pH dependent. At pHs less than 9.2, cyanide usually exists as hydrogen cyanide. In the environment, cyanide is most often found in the forms of hydrogen cyanide or metallocyanides.

Cyanide complexes have low to moderate solubility in water, and vapor pressures range from very low to very high. As a result, cyanide can have mobilities ranging from very low to very high. Hydrogen cyanide is generally considered the most mobile form, being easily soluble in water and tending to volatilize readily. Biodegradation is also a viable release mechanism. Cyanide in complexes with either metals or anions is generally less mobile and tends to adsorb to soils. In addition, cyanide complexes are typically denser than water and will sink in water systems as saturation is approached.

5.2.8.2 Anions. The anions analyzed for in groundwater at this Site (Cl, NO_3/NO_2, SO_4, and P) are naturally occurring in the environment and are necessary nutrients for sustaining living organisms. Upon release to water, anions, with the exception of P, will dissociate into their ionic forms. In their ionic forms, anions are very stable and preferentially remain mobile in water. Anions may precipitate out of water after chemical complexation under certain conditions such as complexation with other chemical components or changes to the water system (e.g., pH, metal concentrations, etc).

5.3 FATE AND TRANSPORT PROCESSES

It is evident from the data presented in section 4.0 that releases of chemicals to the environment have occurred from various areas of concern within the Site, and that these chemicals have migrated to some extent into soil, groundwater, sediment and surface water. There are several transport pathways and processes that govern the mobility and fate of these chemicals at the Site.

The following text discusses potential migration pathways and transport processes in general terms within each medium and at various areas of concern within the Site. Background characteristics are also discussed.

5.3.1 Site Fate and Transport

Potential migration pathways in groundwater include transport through the unsaturated zone, by percolation through wastes and contaminated soil, and in the saturated zone by natural groundwater flow. Transport in surface water can occur during storm events by overland flow of surface water after contact with contaminated soils and wastes and suspension of contaminated soils. Once the overland flow waters reach the flowing surface water bodies, contaminated surface water and suspended sediment can migrate further downstream. Contaminated groundwater can also seep into flowing surface water and be transported downstream. Along these migration pathways, several processes may occur that can affect the extent to which chemicals will migrate. As discussed in section 5.2, these processes involve physical mechanisms and chemical reactions between the chemical and environmental media that will act to promote or attenuate chemical migration in the environment.

5.3.1.1 Unsaturated Zone. Most areas of concern within the Site are not covered with impermeable materials. Therefore, precipitation will percolate vertically through these areas. Within the unsaturated zone, when percolating water comes into contact with waste materials and contaminated soils, many of the chemicals will dissolve and migrate with the water as a dissolved phase through the unsaturated zone and possibly reach the saturated zone.

The unsaturated zone is a very active area where many chemical transformations and phases occur. Factors such as high organic carbon content, metal oxide species, and soil structure can substantially affect the rate of movement of chemicals through the unsaturated zone. In this zone, chemicals can readily partition into solid or liquid and gaseous phases because of physical interactions including volatilization, dissolution, and adsorption as well as chemical interactions including biodegradation, hydrolysis, oxidation/reduction, and precipitation. The phase in which a chemical exists in this zone can greatly affect the mobility or persistence of the chemical in subsurface materials.

Adsorption will be the dominant fate mechanism for most chemicals at the Site. The chemicals with the higher K_{oc} values will adsorb to organic soil particles and organic matter. Pesticides, PCBs, and most SVOCs (PAHs, phthalates) have relatively high K_{oc} values and therefore will not migrate appreciably as a dissolved phase in the unsaturated zone. Adsorption of metals through various processes will also occur in the unsaturated zone.

Other processes such as biodegradation, hydrolysis, and volatilization cause attenuation of chemicals once they have dissolved in percolating water. Chlorinated solvents, however, will migrate in a dissolved phase in the unsaturated zone. In general, if any chemical is in DNAPL form, greater mobility and more widespread dissolved plumes can be expected due to the greater depth of penetration of a highly concentrated form of the chemical.

The vapor phase could be a significant migration pathway for volatile chemicals in the unsaturated zone. Where VOCs exist in the unsaturated zone, a vapor plume will develop in the surrounding soil gas. A groundwater plume in the unsaturated zone can form when percolating water contacts the vapor plume. A vapor plume may migrate laterally by diffusion or in soil gas generated by a landfill and dissolve into water in the unsaturated zone and at the water table in the saturated zone.

5.3.1.2 Saturated Zone. Within the saturated zone, dissolved chemicals will migrate in the direction of groundwater flow. If present in sufficient volume, DNAPLs will migrate vertically and laterally under a density driven gradient (not always in the direction of groundwater flow) and will slowly dissolve, creating a dissolved phase plume. Biodegradation, hydrolysis, oxidation, reduction, and ion exchange also occur in the saturated zone. However, due in part to lower oxygen levels and nutrient levels in the saturated zone, conditions are not always adequate to make these processes significant attenuation mechanisms. Adsorption is likely the dominant attenuation mechanism in the saturated zone.

The time of travel of chemicals in the dissolved phase is largely a function of the seepage velocity and attenuation by adsorption. In contaminant fate and transport evaluations, the attenuation due to adsorption (retardation) of a chemical can be described by the following equation (Freeze and Cherry, 1979):

$$v/v_c = 1 + \rho_b/n \times K_d$$

Where:

v = seepage velocity

v_c = velocity of the contaminant front

ρ_b = dry bulk density of the soil

n = porosity

K_d = Distribution coefficient

The term $1 + \rho_b/n \times K_d$ is referred to as the retardation factor, R. The effect of retardation, described in terms of velocity, is that the velocity of the chemical will travel R times slower than the velocity of groundwater. The effect, described in terms of travel time, is that the travel time of a chemical would be R times greater than the travel time of groundwater.

To compare the effects of retardation, values of R for the most mobile chemicals within the prevalent chemical groups of contaminants (PCBs, pesticides, SVOCs, and VOCs) detected in a typical soil and groundwater setting at the Site (ρ_b = 1.69 g/cm^3, n= 0.3) were calculated and are shown below. In addition, for a maximum seepage velocity of 1 foot/day for overburden (see section 3.0), velocities for representative compounds within the chemical groups are shown below for groundwater.

Chemical Group	K_d (ml/g)	R	v_c (feet/day)
PCBs	4.3×10^4	2.5×10^5	4.0×10^{-6}
Pesticides (DDT)	1.9×10^4	1.1×10^5	9.3×10^{-6}
SVOCs (PAHs: Naphthalene)	1.1×10^2	6.3×10^2	1.6×10^{-3}
SVOCs (Phthalates: Bis (2-ethylhexyl))	4.8×10^2	5.9×10^3	1.7×10^{-4}
VOCs (Chlorinateds: TCE)	1.1×10^1	6.3×10^1	1.6×10^{-2}
VOCs (Ketones: acetone)	1.8×10^{-1}	2.2×10^0	4.5×10^{-1}
VOCs (Aromatics: Benzene)	0.081	8.3×10^1	1.2×10^{-2}

These calculations indicate that PCBs, pesticides, and most SVOCs are highly retarded in the saturated zone. The retardation factor is also applicable to metals. However, since K_d is difficult to quantify for metals, the usefulness of R for evaluating transport of metals is limited.

In general, the shallow and deep overburden flow zones contain some amount of organic matter that will retard contaminants. Some areas may contain more organic matter than others. Contaminants will also disperse in the aquifer because of the tortuous path through soil pores.

Within fractured crystalline bedrock, there is typically less organic matter to facilitate adsorption. Advection will dominate because the fractures offer a less tortuous path with less opportunity for dispersion of contaminants. Also, the low porosity of the rock matrix will minimize the diffusion process. Thus, once contaminants reach the bedrock, minimal attenuation from these processes can be expected.

Generally, groundwater flows through fracture openings, which are generally small in size (tens of microns; Freeze and Cherry, 1979) and account for less than 1% of the bulk volume of rock. Fractures in most natural settings have preferred orientations. The intersections of the fractures create the geometric network of the fracture system. The direction of groundwater flow and contaminant transport in fracture systems is dependent on the orientation and connectivity of the network. At this Site, the bedrock is known to be jointed and fractured as evidenced by bedrock outcrops, drill cuttings, and cores. The predominant fracture orientation is north-northeast consistent with the primary flow direction. Due to greater confining pressures, fractures generally decrease in width and number with depth (Garrett, 1988). Consequently, the lateral movement of water through fractures generally decreases with depth.

If DNAPL exists in the saturated zone, it will be in residual or pooled form. Pooling will occur wherever there are capillary barriers, (such as fine-grained lenses or competent bedrock), that are resistant to DNAPL penetration. Both residual and pooled DNAPL will slowly dissolve away until their volume is depleted. The dissolution of DNAPL to depletion could take many years, often decades (Pankow and Cherry, 1996). If DNAPL pools are above or within fractured crystalline bedrock, they have the potential to migrate a significant distance from the source area. The reason for the migration is that very little dilution will occur within the fractures and very little diffusion will occur into the relatively non-porous rock matrix. The depth of DNAPL penetration within fractured bedrock will depend on the fracture aperture width, entry pressure, the dip of the fractures, DNAPL volume and density. Penetration depth is very difficult to predict even in the most characterized bedrock settings (Pankow and Cherry, 1996). Although there is evidence of NAPL at the Site, low concentrations of potential DNAPL-forming compounds in groundwater suggest that substantial pooled DNAPL is unlikely in the overburden and bedrock flow zones. Residual forms of DNAPL are more likely.

5.3.1.3 Surface Water Transport. Generally, inflow to surface water within the Site consists of groundwater discharge, overland flow runoff, and direct rainfall. Different surface water locations within the Site exhibited some degree of pesticides, PAHs, and elevated concentrations of some metals, with a few exhibiting VOCs and other SVOCs. Within most of the Site, groundwater most likely discharges to surface water and, in the process, contributes contaminants to surface water. Adsorption to sediments before they reach surface water is likely the primary attenuation mechanism for many contaminants. Once the contaminants are in the surface water, a variety of mechanisms occur that tend to reduce concentrations, including dilution, volatilization, photolysis, hydrolysis, oxidation, reduction, and biodegradation. The more strongly adsorbed compounds such as pesticides, PCBs, and SVOCs may not be detected in surface water unless suspended solids are high such as would be the case after a storm event.

Major metal ions and heavy metals occur naturally in surface water. Elevated metals concentrations above background levels are likely the result of the contaminated groundwater and surface water discharge from the Site.

Overland flow runoff at the Site will drain to the east and northeast, carrying with it dissolved contaminants and eroded sediments. Runoff is a potential source of contaminants in the canals, the unnamed brook, and wetlands to the east.

5.3.1.4 Sediment Transport. Sediment transport occurs though overland flow runoff and scouring and resuspension in flowing surface water bodies. Within the Site, primary transport pathways include overland flow runoff from the areas of concern and resuspension in the Middlesex Canal and the unnamed brook. Pesticides appear to be ubiquitous across the Site. PCBs are prevalent in sediments within the Middlesex Canal due to past discharges from the former Johns-Manville facility (currently BNZ Materials property). PAHs are prevalent throughout most of the Site. Since most sediments at the Site are inherently high in organic matter, these contaminants will strongly adsorb to sediments in the canals, the unnamed brook, and the wetlands.

Surface water velocities are not high within the Site. Therefore, scouring and resuspension of sediments is not a dominant transport mechanism. However, during storm events, surface water flows will be higher, and more scouring and resuspension can be expected.

5.3.2 Background

It is important to consider background concentrations in the evaluation of contaminant fate and transport to avoid misinterpretation of how certain chemicals may have reached a certain location within the Site. Certain chemicals may occur naturally or may exist due to external factors unrelated to Site activities. In general, if a chemical concentration in any medium is detected above background concentrations in the same medium, it is evidence that the chemical may have been derived from the Site. In this context, the chemical is referred to as having elevated concentrations (above background). Background characteristics are summarized here for clarity. Section 4.0 should be referenced for a more complete discussion of background characteristics.

Background soils were found to contain several pesticides, whereas no VOCs, SVOCs, or PCBs were detected. The detection of pesticides at all background locations demonstrates the ubiquitous nature of pesticides. The absence of VOCs, SVOCs, and PCBs suggests that, where these chemicals are found on the Site, they are likely the result of Site activities. All of the metals detected in background were found within respective concentration ranges for soil samples from the eastern United States and Massachusetts, with only a few exceptions (see section 4.0).

As with soils, background sediments were found to contain several pesticides. Sediments also contained several SVOCs (mostly PAHs) and some PCBs and VOCs. Major metal ions were detected as well as some heavy metals.

As with sediment, several pesticides and PAHs were detected at background surface water locations. No VOCs or PCBs were detected. Major metal ions were detected as well as some heavy metals.

Only three organic compounds were found in Site background groundwater (carbon disulfide, PCB Aroclor 1260, and petroleum hydrocarbons). No pesticides or other VOCs, SVOCs, or PCBs were detected in groundwater. Some major metal ions and a few heavy metals were detected.

5.3.3 B&M Railroad Landfill

The B&M Railroad Landfill is a 14-acre former wetland area that was filled with various types of debris. Buried drums and railroad and construction materials were observed in this area. Impermeable cover materials overlying the waste were not present. The most significant analytes detected in this area include VOCs (aromatic and chlorinated), petroleum hydrocarbons, phenolics, phthalates, PAHs, pesticides, PCBs, and some heavy metals. These analytes were detected in surface and subsurface soils, surface water, sediment, and groundwater in the vicinity of the landfill. Geophysical surveys in this area exhibited an anomaly in the southeast portion of the landfill, possibly indicating a concentrated area of debris. Some of the highest concentrations of PAHs, phenolics, phthlates, and petroleum hydrocarbons were found in the same portion of the landfill. Boring logs suggest that landfilled material may be above and below the water table. Peat deposits underlie the fill material over much of the Site, providing a source of organic matter for adsorption of reactive contaminants. The peat is underlain by glacial outwash and then bedrock.

5.3.3.1 Unsaturated Zone Transport. Of all media at the landfill, subsurface soils exhibited the highest concentrations of contaminants. With the absence of a low-permeability cover, rainwater can potentially percolate through the unsaturated soils, wastes, and contaminated materials. When in contact with the percolating water, the contaminants will dissolve and migrate with the water through the unsaturated zone to the saturated zone. The contaminants will be attenuated by several mechanisms. The organic compounds with the higher K_{oc} values will adsorb to organic soil particles and organic matter. Since this landfill was once a wetland area, organic soils (peat) are prevalent here. PCBs, PAHs, and pesticides all have relatively high K_{oc} values and therefore will not migrate appreciably in a dissolved phase in the unsaturated zone.

Because of past disposal practices, the landfill may contain small amounts of pure-phase product (NAPL), either due to spilling on the ground surface or leaching from buried materials such as small containers (drums or capacitors). Some of the containers could have held PCB oils derived from waste hydraulic fluids in locomotive braking systems. The presence of chlorinated solvents suggests that these types of organic compounds may also have been disposed of as liquids. The presence of high concentrations of PAHs suggests that there may be liquid creosote within the landfill. Although NAPL was not observed in monitoring wells in the landfill, evidence suggesting NAPL, in the form of oily sands, was observed in the first few feet during the advancement of the boring for the MW-214 cluster, which also exhibited high PAH concentrations.

High concentrations of PCBs in subsurface soils suggest that a highly concentrated PCB material, possibly PCB oils, was disposed of in this landfill. Subsurface borings also show relatively high concentrations of pesticides, PAHs, phthalates, and aromatic VOCs. Since PCB oils are typically denser than water, they would migrate as DNAPLs. PAHs and aromatic VOCs are indicative of coal tar and creosote wastes. Creosote is only slightly denser than water and has a very high viscosity. Consequently, it will not be as mobile as the denser, less viscous DNAPLs. Disposal of large amounts of pure-phase organic chemicals is not likely in this area because waste disposal practices differ from typical industrial solvent sites. Therefore, it is likely that, if DNAPLs exist in this landfill, they are in residual form and are not migrating. However, even in the residual form, depletion by dissolution could take several years, resulting in the presence of dissolved phase plumes for as many years.

There is a notable absence of PCBs in surface soils, suggesting that the existence of PCBs in subsurface soils is most likely due to buried material. Similar types of pesticides, but generally lower concentrations were found in subsurface soils in comparison to surface soils. Since pesticides are very persistent (i.e., will not dissolve into percolating water), minimal vertical migration of pesticides is expected unless the pesticides are a component of a DNAPL. Since pesticides are ubiquitous at the Site due to likely widespread application, it cannot be stated conclusively whether pesticides were disposed of in their pure-phase in the landfill. However, the elevated pesticide concentrations in subsurface soils, and the fact that their low mobility would limit migration in the dissolved phase, suggest disposal of pesticides at this Site.

High SVOC concentrations were found in both surface and subsurface soil. As with pesticides, most of these compounds, particularly PAHs and phthlates, are persistent, and minimal migration through dissolution would be expected. Thus, PAH compounds associated with railroad wastes (e.g., creosote-soaked ties) will not migrate significantly.

Metals will also be relatively immobile in the unsaturated zone due to adsorption and the fact that most metals are insoluble. However, depending on the soil chemistry and other factors such as the presence of organic acids and solvents, and cation exchange capacity (CEC) of the soils, leaching of metals could occur.

Another migration pathway for VOCs in the unsaturated zone is through the vapor phase since VOCs were detected more often above the water table than below it. Although vapor concentrations were generally low, organic vapor readings of greater than 10,000 ppm were measured in boreholes and test pits, indicating potential localized vapor phase sources within the landfill.

5.3.3.2 Saturated Zone Transport. With the exception of VOCs, most organic compounds found in the saturated zone at the B&M Railroad Landfill will not migrate significantly in a dissolved phase. The PCBs, pesticides, PAHs, and phthalates detected have a tendency to adsorb to organic matter, such as the peat material directly underlying fill material throughout much of the landfill. While adsorption of VOCs also occurs, in general VOCs have higher solubilities and may form significant dissolved-phase plumes. In comparison to subsurface soil concentrations, groundwater data for the area exhibit relatively low concentrations of pesticides, PCBs, PAHs, and phthalates but more similar concentrations of VOCs, supporting the hypothesis of plume formation. Although NAPL was not observed during field activities, it may exist in residual form in the saturated zone, causing a continuous release in the dissolved phase.

As in the unsaturated zone, most metals will be relatively immobile in the landfill soils due to adsorption and the fact that most are not soluble in water. However, depending on the soil chemistry and other factors such as the presence of organic acids and solvents and CEC of the soils, migration of metals in groundwater is possible.

The potential for biodegradation of chlorinated compounds is evidenced by the existence of TCE and its potential byproducts, 1,1-DCE and *cis-* and *trans-*1,2-DCE, in groundwater. The rate of biodegradation is difficult to determine without supplementary site data. Typically, anaerobic degradation of chlorinated compounds in natural aqueous systems will not cause substantial attenuation. However, degradation of chlorinated compounds such as PCE and TCE could contribute daughter products to groundwater that are equally or more toxic (e.g., DCE and vinyl chloride). Some PAHs and phthalates may also biodegrade.

The groundwater data indicate that downgradient and vicinity wells in the shallow and deep overburden and bedrock flow zones have higher concentrations of metals than upgradient wells and background wells in the same flow zones. Similar observations were made of surface and subsurface soils. These results indicate that chemicals are migrating vertically at the landfill. The extent of attenuation is difficult to quantify, although adsorption is likely the predominant mechanism.

Judging from the direction of groundwater flow, contaminants in the dissolved phase will migrate from the landfill toward the B&M pond to the east and to Middlesex Canal to the south. Low seepage velocities (ranging from 0.003 feet/day in the bedrock flow zone to 0.02 feet/day in overburden flow zone), combined with high attenuation of most contaminants by the organic soils, probably results in very localized dissolved-phase plumes. Although vertical gradients tend to move upward from deep to shallow groundwater, there is evidence that concentrations of some organic compounds increase with depth at monitoring wells locations, particularly MW-213B. During the drilling of MW-213B, elevated headspace PID readings (20 ppm to 25 ppm) on outwash samples taken just above the bedrock surface suggest that a concentrated area of chlorinated VOCs exist within the deep overburden. In addition, organic compounds that are not mobile in a dissolved phase, such as PCBs and pesticides, have been detected below the limits of waste material in the deep overburden and bedrock flow zones. One potential explanation for these observations is that mobile DNAPLs migrated vertically against the upward hydraulic gradient to form residual or pooled DNAPL, causing groundwater contamination at depth. The vertical gradients tend to be very weak in this area and therefore do not significantly inhibit vertical migration of DNAPL. The DNAPL may be chlorinated solvents or PCB oils or a DNAPL mixture of a variety of chemicals. The high PID reading may indicate that a pool of DNAPL was encountered on the bedrock surface. However, NAPL was not observed during the field activities.

Groundwater data indicate elevated metals concentrations consistent with subsurface soils. These concentrations are in general greater than upgradient wells and background locations, which is indicative of an impact from the landfill.

5.3.3.3 Surface Water and Sediment Transport. Surface water around the B&M Railroad Landfill exhibits pesticides and PAHs, whereas sediments exhibit pesticides, PCBs, VOCs, PAHs, and other SVOCs. A variety of mechanisms occur in surface water that tend to reduce contaminant concentrations, including dilution, volatilization, photolysis, hydrolysis, oxidation, reduction, and biodegradation. The less soluble compounds such as pesticides, PCBs and SVOCS, may not be detected in surface water unless suspended solids are high. Adsorption to sediments makes these contaminants unavailable for these processes and is considered the primary reason that these contaminants are more prevalent in sediment. Measured vertical gradients at seepage meters indicate that groundwater from the landfill discharges to the Middlesex Canal. The absence of contaminants in surface water from contaminated groundwater that discharges to the surface water is likely due to the attenuation processes mentioned above.

Contaminants detected in sediment within the Middlesex Canal adjacent to the landfill may have resulted from groundwater discharge from the landfill, sediment transport from the landfill through surface water drainage, and sediment transport from upgradient reaches of the unnamed brook. Most contaminants found in sediments adjacent to the landfill have also been found in upgradient reaches. PCBs in the Middlesex Canal may be the result of historic upstream discharges from the stormwater drain system at the former Johns-Manville facility (currently BNZ Materials property). PCBs tend to be very persistent in the environment. Where conditions such as scouring flow rates and resuspension of sediment are absent, as is the case in the canal, PCBs may remain for several decades.

5.3.4 RSI Landfill

The RSI Landfill was originally a sand and gravel borrow pit. Reportedly, municipal and construction/industrial wastes were disposed of for a limited period. The landfill materials are characterized as sandy fill mixed with refuse, railroad ties, and abundant metal objects. The waste materials appear to be localized in the west central portion of the landfill. There is no documentation of cover materials. The most common contaminants found at this landfill include VOCs (mostly aromatic VOCs), SVOCs (PAHs and phthalates), PCBs, and some heavy metals. Bedrock is shallow in the vicinity of the landfill, as evidenced by granite outcrops in the central portion of the area. Bedrock is overlain by glacial outwash deposits and the fill material.

5.3.4.1 Unsaturated Zone Transport. The borings performed at the landfill indicate that wastes exist above and below the water table. Of all media, subsurface soils exhibited the highest concentrations of detected contaminants. As with the B&M Railroad Landfill, in the absence of a low-permeability cover, rainwater can potentially percolate through the wastes and contaminated materials. When in contact with the percolating water, soluble contaminants will dissolve and migrate with the water in a dissolved phase through the unsaturated zone to the saturated zone. As in the B&M Railroad Landfill, relatively elevated concentrations of PCBs, PAHs, and phthalates are located in the unsaturated zone. When present in percolating water, these compounds may be highly attenuated through adsorption. In the DNAPL form; however, these compounds may migrate vertically.

In general, the presence of more heavy metals at higher concentrations corresponded to locations where waste was present. Most metals will also be relatively immobile in the landfill soils due to adsorption and the fact that most are not soluble in water. However, depending on the soil chemistry and other factors such as the presence of organic acids and solvents and CEC of the soils, leaching of metals is possible.

Although chlorinated VOCs were not found abundantly in subsurface soils or at shallow groundwater wells, they were detected in groundwater-screening samples taken at the water table. One possible explanation for this is that VOCs in the unsaturated zone are migrating in the vapor phase. Where VOCs exist in the unsaturated zone, a vapor plume may develop in the surrounding soil air. A groundwater plume in the unsaturated zone can form when percolating water comes into contact with the vapor plume. A vapor plume may also migrate laterally in soil gas generated from the landfill and dissolve into water at the interface of the unsaturated and saturated zones. Chlorinated VOCs including 1,1-DCE, *cis*-1,2-DCE, and vinyl chloride were detected in samples collected at or near the water table. These compounds are typical breakdown products of PCE and TCE, which themselves were not detected at screening locations. Vinyl chloride is very volatile. Therefore, if it exists in the unsaturated zone, vapor phase movement and dissolution of the vapor phase in percolating water and at the water table may be a prominent transport mechanism.

5.3.4.2 Saturated Zone Transport. With the exception of VOCs, most organic compounds found in the saturated zone at the RSI Landfill will not migrate significantly in a dissolved phase. Pesticides, PAHs, phthalates, and PCBs adsorb to organic matter. However, in this landfill, their mobility may be greater than in other areas of concern (e.g., B&M Railroad Landfill) due to the more sandy, less organic nature of soils. While adsorption of VOCs still occurs, most VOCs have high solubilities, and therefore significant dissolved-phase plumes could form. In contrast to the high concentrations found in subsurface soil, groundwater data for this area demonstrated very low concentrations of PCBs, pesticides, the absence of PAHs, and only one detection of phthalates. However, the concentrations of VOCs in subsurface soil and groundwater were more similar in magnitude, supporting the hypothesis of plume formation for these more soluble compounds.

The groundwater data indicate elevated metals concentrations, highlighted by elevated iron and arsenic concentrations. As in the unsaturated zone, most metals will also be relatively immobile in the area soils due to adsorption and the fact that most are not soluble in water. However, depending on the soil chemistry and other factors such as the presence of organic acids and solvents and CEC of the soils, migration of metals in groundwater is possible. Arsenic, in particular, can by very mobile in water given appropriate soil chemistry conditions.

The concentrations of all compounds are generally less than 1% of their solubility, which is an indication that mobile NAPLs are not prevalent in the saturated zone. However, small amounts of NAPL could exist in residual form in the saturated zone, causing a continuous release of the dissolved phase.

The potential for biodegradation of chlorinated compounds is evidenced by the existence of byproducts 1,1-DCE, *cis*- and *trans*-1,2-DCE, and vinyl chloride at groundwater-screening locations. The rate of biodegradation is difficult to determine with the limited amount of site data. Typically, anaerobic degradation of chlorinated compounds in natural aqueous systems will not cause substantial attenuation of the parent compounds.

Based on the direction of groundwater flow, contaminants in the dissolved phase will migrate toward the wetlands, Middlesex Canal, and the B&M Railroad Landfill to the northeast and to the unnamed brook to the southeast. The low seepage velocities (ranging from 0.02 feet/day in bedrock to 0.24 feet/day in overburden), combined with high retardation of most contaminants by the soils, likely result in a localized dissolved-phase plume. Although vertical gradients tend to be very low (both upward and downward), there is evidence that concentrations of some contaminants (e.g., chlorinated VOCs) increase with depth (e.g., MW-212 cluster, OW-01/02/03 and OW-07/08 clusters). In addition, contaminants that are not mobile in a dissolved-phase, such as PCBs and pesticides, have been detected in deep overburden and bedrock groundwater flow zones (i.e., below the limits of the fill material). One potential explanation for this is that mobile DNAPLs have migrated vertically to form pooled or residual DNAPL causing a dissolved-phase plume to form at depth. The DNAPL may consist of chlorinated solvents or PCB oils or a DNAPL mixture of a variety of compounds. The existence of shallow bedrock and bedrock outcrops are also conducive to contaminant travel to bedrock.

Chlorinated VOCs, 1,1-DCE, *cis*-1,2 DCE, and vinyl chloride, were found at groundwater-screening locations but were not found in shallow overburden wells. This may be explained by the fact that the screening samples were collected at the water table where the saturated zone may be contaminated by dissolution from the vapor phase. Shallow overburden wells are screened below the water table at a point that may be below the contaminated groundwater.

Chlorinated VOCs were also detected in wells upgradient of the landfill, indicating that the landfill may not be the only source of these compounds, particularly in the deep overburden and bedrock flow zones. Chlorinated VOCs in fractured crystalline bedrock may be very mobile because organic carbon content in the bedrock is likely to be low and limited dilution within fractures will occur. Chlorinated VOCs were also detected near the outfall pipe near SW/SD-322, located in the sedimentation pond on the unnamed brook.

5.3.4.3 Surface Water and Sediment Transport. Surface water samples collected near the RSI Landfill exhibited pesticides and elevated concentrations of VOCs, whereas sediment samples exhibited pesticides and elevated concentrations of VOCs and SVOCs. However, the detection of these organic compounds upgradient of the landfill and in the proximity of the Johns-Manville Asbestos Landfill and the unnamed brook make it difficult to determine the actual source of these contaminants. Measured vertical gradients and flow in seepage meters indicate that groundwater from the RSI Landfill discharges to the unnamed brook. Possible evidence of this is the detection of aromatic VOCs in sediment and chlorinated VOCs in surface water at SW/SD-301. Both of these types of VOCs were also detected in shallow groundwater at the landfill.

Surface water runoff from this area could also be a source of contamination since pesticides, SVOCs, and VOCs were detected in surface soils at the landfill.

5.3.5 B&M Locomotive Shop Disposal Areas (A and B)

The B&M Locomotive Shop Disposal Area consists of two areas separated by a man-made canal. Area A is north of the canal and is 1 acre in size. Area B is south of the canal and is approximately

5 acres in size. A thin layer of topsoil and fill covers Area A. Creosote-soaked railroad ties, old railroad ties, and other debris are exposed at the surface in Area A. Various forms of debris including ash, metal, plastic, rubber, wood, brick, asphalt and glass were found during invasive activities at Area A. Area B is relatively flat and is covered with light-colored sand. Large buried metal objects were found during invasive activities at Area B.

Area A is underlain by glacial outwash, which itself is underlain by weathered bedrock and then competent granitic bedrock. Area B geology consists of glacial outwash underlain by ablation till, then basal till, and then weathered bedrock and competent granitic bedrock.

5.3.5.1 Unsaturated Zone Transport. The borings performed at the two disposal areas indicate that wastes exist above and below the water table. Of all media, subsurface soils exhibit the highest concentrations of organic compounds. In both areas, the organic compounds with the highest concentrations were PAHs. Other organic compounds detected in relatively low concentrations include pesticides, PCBs (Area B only), VOCs, and petroleum hydrocarbons. Elevated concentrations for some metals were also detected. As with the other disposal areas, in the absence of a low-permeability cover, rainwater can potentially percolate through the wastes and contaminated materials. When in contact with the percolating water, soluble contaminants can dissolve and migrate with the water in a dissolved phase through the unsaturated zone to the saturated zone. The contaminants may be attenuated by several mechanisms. Contaminants with higher K_{oc} values (i.e., PAHs, PCBs, and pesticides) will adsorb to organic soil particles and organic matter. PAHs, PCBs, and pesticides all have relatively high K_{oc} values and therefore will not migrate significantly in a dissolved phase in the unsaturated zone.

Metals concentrations observed in soils were elevated in comparison to background soils. Both surface and subsurface soils exhibited elevated concentrations of copper and lead. Both of these metals are subject to adsorption by cation exchange. However, in the absence of soils with high CEC (e.g., clays), they can be mobile.

Because of past disposal practices, both areas may contain pure-phase product. Although NAPL was not observed in groundwater, evidence of NAPL in the form of oily wastes has been observed in subsurface soils (Phase 1A RI).

PAHs and petroleum hydrocarbons are indicative of coal tar and creosote wastes as well as fuel oils. Creosote is slightly denser than water and has a very high viscosity. Thus, if present, it will act as a DNAPL but will not be as mobile as the denser, less viscous DNAPLs.

PCBs were detected at only one location within this area (in Area B), indicating that PCBs are not as prevalent as they were in the B&M Railroad Landfill and the RSI Landfill. Similar types of pesticides but at generally lower concentrations were found in subsurface soils. Since pesticides are very persistent (i.e., will not readily dissolve into percolating water), minimal vertical migration of pesticides is expected unless pesticides are a component of a DNAPL mixture. Since pesticides are ubiquitous at the Site, it cannot be stated conclusively whether pesticides were disposed of in these areas.

5.3.5.2 Saturated Zone Transport. PAHs, petroleum hydrocarbons, and aromatic VOCs were notably absent in groundwater, given that these types of organic compounds were prevalent in subsurface soils. The absence of PAHs in groundwater is evidence that these compounds are strongly adsorbed to soils. The absence of the aromatic VOCs and petroleum hydrocarbons could be explained by the fact that the well screens did not extend above the water table and the wells were screened below the dissolved-phase plumes that may have formed.

There were no contaminant concentrations that were near 1% of their solubility, which is an indication that NAPLs are not prevalent in the saturated zone.

The potential for biodegradation of chlorinated VOCs is evidenced by the existence of the breakdown products 1,1-DCE and vinyl chloride at groundwater-screening locations. The rate of biodegradation is difficult to determine without supplementary site data. Typically, anaerobic degradation of chlorinated VOCs in natural aqueous systems will not cause substantial attenuation.

Groundwater data were marked by elevated major metal ion concentrations. The detection of heavy metals was less frequent, but concentrations were still elevated above the levels at background and upgradient wells. These data are consistent with soils data indicating that the same metals could be attributed to the wastes within the area.

Judging from the direction of groundwater flow, contaminants in the dissolved phase will migrate toward the northeast with local shallow groundwater discharge to the unnamed brook between the two areas. Low seepage velocities (ranging from 0.006 feet/day in bedrock to 0.80 feet/day in overburden), combined with high attenuation of most contaminants by the organic soils, probably result in localized dissolved-phase plumes. Vertical gradients tend to be downward from shallow to deep groundwater; however, there is no evidence that vertical migration of contaminants has occurred.

5.3.5.3 Surface Water and Sediment Transport. Surface water samples collected in the canal between Areas A and B (SW-317) exhibited pesticides only, whereas sediment samples taken between the areas (SD-317) and north of Area A (SD-318) exhibited levels of PAHs, pesticides, phthalates, PCBs, and petroleum hydrocarbons. Of these groups of compounds, the latter three were not detected in background and therefore could be attributed to the Area. A variety of mechanisms occur in surface water that tend to reduce concentrations, including dilution, volatilization, photolysis, hydrolysis, oxidation, reduction, and biodegradation. The less soluble compounds such as pesticides, PCBs, and SVOCS may not be detected in surface water unless suspended solids are high. Adsorption to sediments makes these contaminants unavailable for these processes in surface water and is likely one of the reasons that more contaminants and higher concentrations are found in sediment than in surface water. Another possible reason is that direct discharges to the channel occurred in the past and the chemicals have persisted over time as evidenced by PCB concentrations in sediments that were much higher than in soils or groundwater. Measured vertical gradients in seepage meters indicate the potential for groundwater discharge from both the overburden and the bedrock. However, measured streambed conductivities are low, limiting groundwater discharge.

Contaminants detected in sediment within the canal may also be the result of sediment transport from both Areas A and B through surface water drainage, since surface soils exhibit similar concentrations. Since the unnamed brook travels through both areas and the B&M Locomotive Shop Disposal Areas are upgradient of other areas of concern on the Site, these areas could be a contaminant source for the entire brook within the Site boundaries.

5.3.6 Old B&M Oil/Sludge Recycling Area

The Old B&M Oil/Sludge Recycling Area was once used for the recycling of oils. Historical B&M Railroad plans and aerial photographs show pooled areas of oil and sludge. Soil visibly contaminated with oil and sludge has been observed on the surface at this area. The subsurface soils generally consist of black sand/fill, black ash, layers of oily silt/clay, oil-stained soil, free product, and black slag intermixed with waste. Peat was encountered in several borings, indicating that the area was formerly swampy.

5.3.6.1 Unsaturated Zone Transport. The borings performed in this area indicate that wastes exist above and below the water table. Of all media, subsurface soils exhibited the highest concentrations of contaminants. The predominant types of organic compounds detected in subsurface soil include aromatic VOCs (e.g., BTEX compounds), PAHs, and petroleum hydrocarbons. Elevated metal concentrations were also found in surface and subsurface soils. All of these contaminants are characteristic of combustion waste products and fuel or petroleum-related products.

Currently, the surface area is flat and consists of hard-packed sandy fill covered by gravel. There is also asphalt pavement over part of the area. In the absence of a low-permeability cover, rainwater can potentially percolate through the wastes and contaminated materials. When in contact with the percolating water, contaminants will dissolve and migrate with the water as a dissolved phase through the unsaturated zone, potentially to the saturated zone. The contaminants will be attenuated by several mechanisms. Contaminants with higher K_{oc} values (i.e., PAHs and pesticides) will adsorb to organic soil particles and organic matter prevalent in this area (peat), therefore, these contaminants will not migrate appreciably in a dissolved phase in the unsaturated zone. Aromatic VOCs have higher solubilities and therefore will be more mobile than the other less soluble compounds. Metals leaching from the wastes will also tend to be adsorbed by the organic soils.

Based on knowledge of past disposal practices, observations of free product in an on-site piezometer (P-12), and the occurrence of PAHs and petroleum hydrocarbons in subsurface soil, LNAPL in residual or mobile form is potentially widespread in this area. The presence of high concentrations of PAHs also suggests the possible existence of creosote within the area. Therefore, chemicals in the form of DNAPL may also exist.

5.3.6.2 Saturated Zone Transport. PAHs, petroleum hydrocarbons, and aromatic VOCs were notably absent in groundwater, given that these compounds were prevalent in subsurface soils. The absence of PAHs in groundwater is evidence that this group of chemicals is strongly adsorbed to soils. The absence of the aromatic VOCs and petroleum hydrocarbons can also be explained by the fact that the wells were not screened over the water table. Chlorinated VOCs and pesticides were the primary organic compounds found in groundwater. These compound groups are present at similar concentrations throughout the Site and cannot be conclusively attributed to this area.

There were no organic compound concentrations that were near 1% of their solubility, which is an indication that the saturated zone is not significantly affected by NAPLs. However, as stated above, because of high concentrations in subsurface soils, the potential presence of NAPLs cannot be discounted.

The potential for biodegradation of chlorinated VOCs is evidenced by the existence of the breakdown products 1,1-DCE and vinyl chloride in groundwater at shallow groundwater-screening locations. The rate of biodegradation is difficult to determine without supplementary site data. Typically, anaerobic degradation of chlorinated VOCs in natural aqueous systems will not cause substantial attenuation.

Judging from the direction of shallow groundwater flow, contaminants in the dissolved phase will migrate toward the northeast. Groundwater flow in the deep overburden is more easterly and may be affected by a bedrock trough, which partially underlies the area. Low seepage velocities (ranging from 0.01 feet/day in bedrock to 0.056 feet/day in overburden), combined with high attenuation of most contaminants by the organic matter in soils, probably result in localized dissolved-phase plumes. Vertical gradients tend to be downward from shallow to deep overburden and upward from bedrock to deep overburden at the MW-202 and MW-203 clusters. Chlorinated VOCs were detected in the deep overburden and bedrock groundwater, which is most likely the result of vertical migration of these contaminants either as a dissolved-phase or in DNAPL.

5.3.6.3 Sediment Transport. No surface water bodies are associated with this area, and therefore no surface water or sediment samples were taken. However, drainage ditches to the northwest of the area direct surface water runoff toward the unnamed brook on the west side of the Site.

5.3.7 Contaminated Soil Area

This area is approximately 50 acres in size and is located within the B&M railroad train yard. The need to investigate this area was determined based on elevated levels of lead in surface soil as a result of the site-wide soil sampling program conducted during the Phase 1A RI (CDM, 1987). The area contains locomotive engines and boxcars, miscellaneous machinery, creosote-covered railroad ties, lumber, telephone poles, and maintenance buildings. There is visual evidence of oil-soaked soil in parts of this area. In general, the area is covered by gravel and hard-packed fill with some paved areas. Only surface soil sampling was performed in this area. The predominant types of analytes found include PAHs, pesticides, petroleum hydrocarbons, and elevated concentrations of metals. The heavy metals most frequently detected at the highest concentrations were lead (not unexpectedly) and manganese. Since there were no discernable patterns that might indicate specific or isolated sources, it is likely that railroad and industrial activities, many of which are ongoing, have resulted in nonpoint source distribution of these contaminants.

5.3.7.1 Unsaturated Zone Transport. In general, specific disposal activities that have occurred in this area have not been identified. Soil contamination is likely the result of surface discharge and is probably limited to surface soils. Nevertheless, there is a potential for migration through the unsaturated zone by percolation of precipitation. As in other areas, however, the predominant compounds are strongly adsorbed to soils and will not migrate far in a dissolved phase. The one VOC detected, chloroethane, is relatively soluble and therefore, more mobile.

Evidence of free-product spills includes visual observation of oil-soaked or stained soils. If significant volumes of free product were spilled, LNAPL or DNAPL could exist in the unsaturated and saturated zones. However, there is no data to substantiate this.

Elevated levels of lead were detected throughout this area. Lead is relatively insoluble and strongly adsorbed and therefore will not migrate significantly in the unsaturated zone.

5.3.7.2 Surface Water and Sediment Transport. Sediment transport by overland flow runoff from storm events is most likely the predominant transport pathway for this area. Surface water drainage from the Contaminated Soil Area, as in the entire Site, is to the northeast. When erosion occurs during storm events, sediments containing adsorbed contaminants will migrate in this direction.

Most of the contaminants found within this area were found in other areas of concern. Background soils contained pesticides, but not PAHs or VOCs, indicating that these latter contaminants are present as a result of site-related activities. In addition, the elevated metals concentrations, particularly lead, suggest impact from the site-related activities. Based on drainage patterns, the Contaminated Soil Area could be a source of these types of contaminants in surface water and sediments in the unnamed brook, the Middlesex Canal, and various ponds and wetland areas, as the same or similar contaminants were found in each of these waterbodies

No PCBS were found in surface soils in this area, indicating that sediment transport from this area is not the cause of PCBs in surface water and sediments.

5.3.8 Asbestos Lagoons

This area consists of three distinct trenches surrounded by a bermed area. These trenches were used as asbestos lagoons, receiving 50% liquid asbestos slurry. The lagoons are unlined and currently contain solidified asbestos slurry which, when sampled by M&E was not observed to be friable. The two outer lagoons are uncovered, but topsoil or fill covers the middle lagoon. Located southwest of the lagoons (and leading to the Middlesex Canal) are outfalls from stormwater drain pipes of the Johns-Manville stormwater drain system, where discharge of PCBs to the canal has occurred in the past (M&E, 1994b; Appendix A). These stormwater drain pipes do not enter the lagoons. A separate stormwater drain pipe leads from the western edge of the lagoons to the canal. Previous disposal activities resulted in the discharge of different types of wastewater to the lagoon. The geology of this area consists of fill underlain by a layer of organic silt and peat and then by thick outwash deposits. The outwash is underlain by ablation till and weathered and competent bedrock.

5.3.8.1 Unsaturated Zone Transport. Since only sediment sampling was performed and borings were advanced only beyond the edges of the lagoons, the limits of the waste with regard to the water table are not defined. Groundwater elevation data indicate that localized mounding occurs beneath the lagoons. Thus, precipitation likely percolates through the wastes. The predominant organic compounds found were pesticides, which are likely to be strongly adsorbed to soils. No petroleum hydrocarbons or PCBs were found in any of the samples. However, PCBs were detected at low concentrations in adjacent catchbasins (M&E, 1994b). Two VOCs, one phthalate, and one PAH were detected in one of the basins. Also, PAHs were detected more frequently and at higher concentrations adjacent to the catch basins in shallow borings (M&E, 1994b). One deep soil boring, SB-25 was previously advanced in this area. Samples from this boring showed several PAHs at all depths. As with pesticides, the PAHs will not be very mobile due to strong adsorptive tendencies.

Concentrations of several metals were found to be elevated, but calcium concentrations were the most elevated. This finding is attributed to the calcium-enriched minerals in plasterboard materials that were disposed of here.

5.3.8.2 Saturated Zone Transport. Several metals, a few chlorinated VOCs, and PAHs have affected mostly the deep overburden and bedrock groundwater in the Asbestos Lagoon Area. PCBs were detected in shallow wells adjacent to the catch basins associated with the stormwater drain system. Past wastewater discharges, stormwater drain leakage, and mounding caused by rainfall likely induced vertical migration of these contaminants beneath this area. Low concentrations of pesticides found in groundwater in this area could also be the result of percolating rainwater; however, since they were also found in upgradient and background wells, determination of this migration pathway is inconclusive. Of all the chemical groups detected, chlorinated VOCs are likely the most mobile due to their higher solubility.

Groundwater flow in this area is divided, with flow to the northwest towards the Middlesex Canal and to the northeast. Low seepage velocities (ranging from 0.03 feet/day in bedrock to 0.1 to 0.7 feet/day in overburden), combined with high attenuation of most contaminants by the organic soils probably result in high travel times and a localized dissolved phase plume. Vertical gradients tend to be downward from shallow to deep overburden in the vicinity of the lagoons and upward from bedrock to shallow overburden at downgradient wells.

5.3.8.3 Surface Water and Sediment Transport. There appears to be minimal potential for the Asbestos Lagoons to affect surface water and sediment. The berms surrounding the Asbestos Lagoons minimize the potential for overland flow runoff and sediment transport during storm events. Because there is limited runoff, most precipitation percolates through the waste. The increased percolation is likely the reason for the mounding in the groundwater.

According to water levels in the shallow overburden wells and the adjacent seepage meters in the Middlesex Canal, there is the potential for surface water discharge to groundwater. However, based on the low streambed conductivities, surface water and groundwater in the vicinity appear to be poorly connected.

The most significant concern with regard to surface water and sediment in this area is the residual PCBs remaining in sediment at the Johns-Manville outfall locations in Middlesex Canal. In previous reports, M&E and others found that high concentrations of PCBs (primarily Aroclor 1248) still remain at the Johns-Manville outfall located adjacent to the Asbestos Lagoons (M&E, 1994b). M&E concluded that sediments contaminated with primarily PCBs, and to a lesser extent SVOCs, VOCs, and PAHs and metals, are being transported downstream within the Middlesex Canal.

Although it is not known exactly when the PCB discharges occurred, it is likely that sediments have contained PCBs for several decades (since the 1940's). The outfall pipe has reportedly been sealed, and therefore, is no longer a source of contaminants to Middlesex Canal. The fact that PCB concentrations in sediment remain high to the present day (M&E, 1994b) demonstrates the persistence of PCBs in sediments. Based on this evidence, minimal degradation and continual downstream transport of PCB-contaminated sediments can be expected, particularly during periods of high flow (i.e. during storm events).

5.4 SITE-WIDE MIGRATION TRENDS

The environmental data collected during this RI and in previous studies at the Site indicate that the soils, groundwater, surface water, and sediments have been affected by Site activities. Volatile organic compounds, SVOCs, pesticides, PCBs, and elevated metal concentration have been found in all of these media. Conclusions regarding migration of contaminants from one area to another are difficult to make because of the close proximity of the potential source areas, similarities in the types of contaminants found at each of the areas of concern, and the low concentrations of these contaminants in groundwater. However, inferences regarding migration trends can be made based on where the contaminants are found, the mobility of the contaminants, and the physical characteristics of the Site. These migration trends are discussed below.

5.4.1 Surface Soils

Surface soils on the Site have been shown to contain VOCs, SVOCs, pesticides, and metals with a notable absence of PCBs. Since only pesticides were found in background soils, the remainder of the types of contaminant groups could be attributed to the Site. Pesticides, PAHs, and petroleum hydrocarbons were the predominant organic compounds found. These compounds were expected for the following reasons:

- Pesticides were detected in background soils
- Pesticides were widely applied in the past and materials containing PAHs and petroleum hydrocarbons were used at the Site.
- Pesticides and PAHs are very persistent in soils

Since the organic compounds were found across most of the Site, it is difficult to discern site-wide migration trends in surface soil contamination. However, surface soils from the B&M Railroad Landfill, the RSI Landfill, B&M Locomotive and Shop Disposal Areas, the Contaminated Soil Area potentially migrate away from these areas in airborne dust and by erosion from surface water runoff. Migration through erosion is likely in a north-northeast direction, consistent with site-wide drainage patterns. The surface water bodies and wetlands within the Site likely receive sediments eroded by surface water drainage from each of the above areas of concern. With regard to surface water, the Old B&M Oil/Sludge Recycling Area is not adjacent to a surface water body and is therefore a less likely source. The Asbestos Lagoons are also not a likely source since they are contained by berms. PCBs found in surface water body sediments do not appear to be the result of erosion of surface soils since no PCBs were found in surface soils.

5.4.2 Subsurface Soil

Subsurface soils are likely a source of groundwater contamination. The primary contaminants found in subsurface soils are PAHs, pesticides, chlorinated VOCs, aromatic VOCs, and metals. Since all of the areas of concern are not covered with a low-permeability cover, precipitation percolates through wastes and contaminated surface soils and subsurface soils, dissolves contaminants, and transports them to groundwater. Percolating water may also dissolve residual or pooled DNAPL (if it exists) in soil pore spaces. Thus, subsurface soils that are above and below the water table may act as continuous sources of groundwater contamination. Several types of contaminant groups such as PCBs, pesticides, several SVOCs, and metals are very persistent in the organic soils found throughout most of the Site; therefore, chemical loading to the saturated zone and migration within the saturated zone are limited for these contaminants. Migration of most VOCs is a greater concern because of higher solubilities.

5.4.3 Groundwater

Groundwater associated with specific source areas of the Site has been shown to contain elevated levels of VOCs, SVOCs, pesticides, PCBs, and metals. However, the data indicate that concentrations are generally low. Concentrations of the more persistent compounds in groundwater (e.g., pesticides, PCBs, some PAHs, and phthalates) are low relative to concentrations of these organic compounds in subsurface soils, indicating that dissolved-phase plumes are likely very small and localized. Thus, where these organic compounds are detected in groundwater, they are likely present due to a localized source and not due to a source located significantly upgradient of that groundwater.

Concentrations of the more mobile organic compounds (e.g., chlorinated and aromatic VOCs and some PAHs) are higher but are still not high enough to be indicative of significant dissolved-phase plumes. However, these compounds have the potential to migrate further downgradient, possibly to other areas of the Site. For example, the RSI Landfill is upgradient of the B&M Railroad Landfill and could be a contributor of VOCs to the B&M Railroad Landfill, since VOCs were detected in wells at both areas in shallow and deep overburden and bedrock groundwater. However, the data are not conclusive enough to prove or disprove this relationship. A localized groundwater divide near the center of the site causes flow to the north in both the overburden and bedrock. This potentially causes groundwater from the Old B&M Oil/Sludge Recycling Area and the Asbestos Lagoons to flow to the north and not toward the Site and wetlands to the northeast.

In general, vertical hydraulic gradients at the Site are not large and tend to be downward in the southwest portion of the Site and upward in the north and northeast near the wetlands, Middlesex Canal, and B&M Pond. This flow direction indicates that the southwest area may be a groundwater recharge area and the north and northeast area may be a groundwater discharge area. Thus, contaminants found in groundwater, surface water, and sediments in the northeast could be the result of contaminants following this groundwater pattern.

The migration of contaminants in overburden groundwater across the Site is likely attenuated by adsorption to the organic matter in soils, dispersion and degradation. In fractured crystalline bedrock, however, these mechanisms are less prominent; therefore, contaminant migration may be more extensive if a significant interconnected fracture network exists. Fractured bedrock has been encountered at several locations, and levels of mobile organic compounds such as chlorinated VOCs have been found in bedrock, making contaminant migration in bedrock a likely transport pathway.

In some areas, concentrations of some contaminants have increased from shallow to deep overburden and bedrock groundwater. At the B&M Railroad Landfill and the RSI Landfill, this increase has occurred despite there being a upward vertical hydraulic gradient at the times measured. This difference could be evidence that some areas are affected by DNAPL migration to deeper portions of the aquifer. However, the low magnitude of dissolved-phase concentrations suggests that if DNAPL exists, it is not widespread within the Site. Another reason could be contaminant migration in the deep flow zone from other areas of concern on the Site.

The report of elevated concentrations of metals at most areas of concern was expected due to the industrial activities and the discharge of industrial wastes at this Site. In several areas of concern, elevated metals concentrations have been found in deep overburden and bedrock flow zones, which may be indicative of vertical migration in these areas. However, since many of these metals occur naturally, the extent of migration of metals is inconclusive.

5.4.4 Surface Water

The data suggest that surface water has been contaminated at the Site. Organic compounds and elevated metal concentrations were detected in surface water locations across the Site. The same types of organic compounds and metals detected in surface water were also found in soils from the areas of concern at the Site as well as in soils and groundwater from nearby areas of concern. The dominant types of organic compounds detected consist of aromatic and chlorinated VOCs, PAHs, phenolic compounds, and pesticides. For the most part, more organic compounds were detected in June than in September, which may reflect conditions of less groundwater discharge and less runoff in late summer and early fall.

Numerous chlorinated VOCs were found at SW-322 near the sedimentation pond southwest of the RSI Landfill, indicating a possible discharge from either groundwater or subsurface drains in this area. Chlorinated VOCs were also found in the nearby RSI Wetland Area, the Middlesex Canal near the B&M Pond, and the unnamed brook. These occurrences could be explained as the result of downgradient migration of the chlorinated VOCs from the SW-322 location. A more likely explanation is groundwater discharge from the RSI Landfill and B&M Railroad Landfill, since the data suggests that these areas may contain chlorinated VOCs. The Johns-Manville Asbestos Landfill could also contribute contaminated groundwater; however, no subsurface investigations were performed at this area.

Major metal ions and heavy metals were commonly found at many surface water locations as well as at background locations. No discernable migration trends were found, except that the Shaffer Wetlands exhibited the most elevated levels of heavy metals.

5.4.5 Sediments

As with surface water, the data show that sediments have been contaminated at the Site. Organic compounds and elevated metals concentrations were detected in sediments across the Site. The same types of organic compounds and metals detected in sediments were also found in soils from the areas of concern within the Site as well as in soils and groundwater from nearby areas of concern. The dominant types of organic compounds detected consist of aromatic and chlorinated VOCs, PAHs, PCBs, and pesticides. The PAHs, PCBs, and pesticides were all found in background samples (as well as a few VOCs). In general, the concentrations of these compounds were much higher than background levels, indicating a definite impact from the Site and other areas of concern. The most notable areas include the sediment location near the outfall pipe in the sedimentation pond and the Middlesex Canal near the Johns-Manville stormwater drain system and the Asbestos Lagoons. The latter was the primary source of PCB contamination in Middlesex Canal. Although the drain system is now sealed, PCBs remain in the sediments and continue to be transported downstream through resuspension in and deposition from surface water. Current data shows PCB-contaminated sediments 2,000 feet downstream of the outfall location (M&E, 1994b). Since Middlesex Canal discharges to the B&M pond, it is considered a potential receptor.

As with surface water, more organic compounds were detected in June than September, which may reflect the conditions of less groundwater discharge and less runoff in late summer and early fall. In addition, more of an impact was apparent near and east of Pond Street indicating a probable impact from runoff from Shaffer Landfill, Pond Street, and the MBTA railway tracks.

Transport through erosion of surface soil by surface water runoff and through resuspension of sediments in flowing surface water bodies are the primary transport mechanisms for sediments. Transport of contaminated sediment will be most significant during storm events when overland flow runoff from contaminated soil areas occurs and when streamflows are greater.

SECTION 6.0

HUMAN HEALTH BASELINE RISK ASSESSMENT

6.1 INTRODUCTION

This section contains the human health baseline risk assessment for the Iron Horse Park Superfund Site, operable unit 3.

6.1.1 Purpose and Scope of Report

The purposes of the baseline risk assessment are: 1) to evaluate the potential human health risks that may be posed by chemical contamination of the groundwater, surface soil, sediment, and surface water at the Site; 2) to provide information to assist in the selection of the most appropriate remedial alternative, if remediation is deemed necessary; and 3) to provide a basis for determining levels of chemicals that can remain at a site while still adequately protecting human health (U.S. EPA, 1989g). This baseline risk assessment may also be used qualitatively to identify Site conditions (chemicals, exposure pathways, receptors) of greatest potential concern.

According to EPA guidelines (U.S. EPA, 1989g), the baseline risk assessment generally consists of four basic steps that can be summarized as follows:

> **Hazard Identification.** Determination of the nature and amount of chemicals that could be potentially encountered at the Site, and selection of those chemicals that are of potential concern for the assessment of the impact on human health.
>
> **Exposure Assessment.** Quantification of the extent, frequency, and duration of actual or potential exposure to chemicals by pathways relevant to the Site and the activities of potential receptors.
>
> **Toxicity Assessment.** Identification of the types of health effects that could be associated with exposure to these chemicals, determination of the relationship between exposure (dose) and the probability of occurrence of the health impact (response).

Risk Characterization. Estimation of the probability that an adverse health impact may occur as a result of exposure to chemicals in the amount and by the pathways identified and the uncertainty in those estimates.

The baseline human health risk assessment for the Site was conducted using methodologies required by EPA guidelines (EPA, 1989g; 1991b; and 1992b and g). A baseline risk assessment is intended to be site-specific; therefore, site-specific information was incorporated into the evaluation whenever available. In the absence of site-specific information, default assumptions, as specified by EPA guidance, were used.

The baseline human health risk assessment provides estimates of risk, under both current use and hypothetical future use scenarios, to both the central tendency receptor and the reasonably maximum exposed (RME) receptor. Potential contaminant migration pathways are selected that represent reasonable contaminant migration routes. Exposure assessments model human exposure by these pathways according to algorithms in relevant guidelines. In the risk assessment for this Site, exposures were estimated for average (central tendency) and upper-bound RME cases. Variables contributing most to estimates of risk or to the uncertainty in the risk assessment have been identified. Each of these steps is discussed in more detail in the following sections.

6.1.2 Organization

This baseline human health risk assessment consists of several subsections. Section 6.2, Hazard Identification, describes the sampling program, the selection of chemicals of potential concern (COPCs) from among the chemicals identified at the Site, and the determination of exposure point concentrations. Section 6.3, Human Exposure Assessment, describes the selection of receptors and exposure pathways to be evaluated and the calculation of dose to the receptors selected. Section 6.4, Toxicity Assessment, summarizes the toxicity of the COPCs including both potential carcinogens and noncarcinogens. Section 6.5, Risk Characterization, includes a summary of site risks and an uncertainty analysis.

6.2 HAZARD IDENTIFICATION

The purpose of this section is the determination of the type and amount of chemicals present at the Site and the selection of the COPCs with regard to human health.

6.2.1 Site Background

The background samples were collected in areas that showed no disturbance or visual evidence of past industrial or other uses. These locations were not, however, pristine as was discussed in section 4.2. The background data for the media evaluated for human health exposures are initially presented along with the Site data, for informational purposes only. Background analyte concentrations do not impact the selection of Chemicals of Potential Concern (COPCs) or exposure point concentrations.

6.2.2 Site Investigations and Data Summarization

Detailed discussions of sampling approaches and the quality assurance and control activities implemented during the collection of the data are provided in section 2.2. The RI data were validated according to EPA's Contract Laboratory Program (CLP) procedures and guidelines, using both Level III and Level IV data review, as described in section 2.3. The analytical results are discussed in section 4.0. The following process used to summarize the analytical data is in accordance with *Risk Assessment Guidance for Superfund* (*RAGS*) (U.S. EPA, 1989g) and supplemental guidance (U.S. EPA, 1992h).

The analytical data were summarized by environmental medium (i.e., surface soil, sediment, surface water, groundwater) and grouped into source areas. The sample groupings used in the risk assessment are presented in Tables 6-1 through 6-4. Contact with subsurface soil was not identified as a potential exposure pathway for the Site, based on expected future land use.

For each environmental medium, some samples were collected in areas not considered to be affected by site activities. These were referred to as background samples. As discussed in section 6.2.3.2, some chemicals were present in background samples at concentrations considered unacceptable for the protection of human health. For example, maximum levels of arsenic in background surface soil samples exceeded residential risk-based concentrations, levels considered acceptable for residential soil (Table 6-5). Since background samples were not used for the selection of COPCs (section 6.2.3) or in the generation exposure point concentrations, the presence of unacceptable concentrations of some chemicals in background samples does not affect the human health risk assessment.

The arithmetic mean chemical concentrations were calculated by averaging the detected concentrations with one-half the detection limit of the nondetects. According to *RAGS* (U.S. EPA, 1989g), one-half the detection limit is typically used in assessments when averaging nondetect concentrations, because the actual value can be between zero and a value just below the detection limit. The use of the detection limits in calculating arithmetic means results in some uncertainty, as discussed in section 6.5.3.1.

The data were qualified by the analytical laboratory and validated as described in section 2.3. The qualification and validation of the analytical data included a comparison of the site data to corresponding blank (laboratory, field, equipment, and trip) concentration data. Data rejected by the validation (R qualified) were not used. Estimated values (e.g., J qualified) were used in the risk assessment without modification. Analytical data from duplicate samples were averaged together and treated as one result. Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples analyzed after the exclusion of rejected (R qualified) data. The frequency of detection also reflects multiple rounds of data collection.

The surface soil and sediment samples are summarized in Tables 6-5 and 6-6, and sample locations are shown in Figures 2-12 and 2-6, respectively. Soil samples were collected once from 79 locations (i.e., SS-1 through SS-59, SS-61 through SS-74, and SS-78 through SS-83) at the Site between July and September 1993. In addition, a sample was collected at location SD-318, which was originally considered a sediment location but was re-categorized as a surface soil sample. Sediment samples collected from a total of 48 locations at the Site during two sampling rounds, June and September 1993, are evaluated in this risk assessment.

Surface water samples, summarized in Table 6-7, were collected at the same locations as sediment samples (Figure 2-6) during the two sampling rounds in June and September 1993, with the exception of four sediment sample locations (SD-323, SD-324, SD-325, SD-326) where surface water samples were not collected. Groundwater samples, summarized in Table 6-8 and sample locations shown in Figure 2-13, were collected from 28 shallow overburden monitoring wells, 26 deep overburden monitoring wells, and 23 bedrock monitoring wells during two sampling rounds (March/April and September 1995).

Since surface water, sediment, and groundwater samples were collected during two separate sampling rounds, two sets of analytical results were available for most sample locations in these media. To determine the frequency of detection, the analytical results from both sampling rounds were considered as separate values, rather than averaging the two values at one sample location. In addition, each sample result was used to calculate the arithmetic mean, rather than averaging two results at a sample location before calculating the mean.

All soil, sediment, surface water, and groundwater samples were analyzed for TCL organics including VOCs, SVOCs, pesticides, PCBs, and TAL inorganics. Summary tables (Tables 6-5 through 6-8) for chemicals detected in each of the environmental media provide the frequency of detection, sample size, arithmetic mean, range of detection limits, and range of detected concentrations.

6.2.3 Identification of COPCs

The scope of the baseline risk assessment includes identification of COPCs for the human health risk assessment based on the chemical substances found at the Site. This list was developed using the simple screening process described below.

6.2.3.1 Selection Criteria. The maximum detected concentration of a chemical in an environmental medium was compared to risk-based concentrations (RBCs) published by EPA Region III (U.S. EPA, 1995b). The RBCs are chemical concentrations back-calculated using toxicity criteria and either a 1×10^{-6} target risk level for potential carcinogens or a hazard index (HI) of 1 for noncarcinogens. For purposes of this screening analysis, a HI of 0.1 was used to add a ten-fold measure of safety to reduce the chance of omitting chemicals from the list of COPCs that could contribute to a total HI of 1.0. To accomplish this, RBCs for noncarcinogenic chemicals were divided by 10 prior to comparison to maximum detected values. Residential soil RBCs were used for comparison to maximum detected soil and sediment concentrations, and tap water RBCs were used for comparison to maximum detected groundwater and surface water concentrations. Maximum contaminant levels were provided for informational purposes during the selection of groundwater COPCs (Table 6-8). The available MCLs were higher than the tap water RBCs; therefore, the use of tap water RBCs for selecting COPCs was considered to be a more conservative screening method.

A maximum detected on-site chemical concentration less than the RBC indicated that the excess lifetime cancer risk associated with exposure to that chemical concentration would be less than one in one million and the HI associated with exposure would be less than 0.1. Chemicals detected at concentrations below RBCs were therefore eliminated from evaluation. All chemicals with maximum concentrations greater than the relevant RBCs were selected as COPCs. The comparisons of maximum concentrations to RBCs are presented in the data summary tables for each medium (Tables 6-5 through 6-8).

Chemicals that lacked RBCs were selected as COPCs, with the following exceptions. For four essential human nutrients that lacked RBCs (i.e., calcium, magnesium, potassium, sodium), the maximum detected concentrations were compared to concentrations in drinking water and soil that would not significantly increase the dietary Allowable Daily Intakes (ADIs), as follows: for calcium (400,000 µg/l water; 4,000,000 mg/kg soil), for magnesium (805,000 µg/l water; 80,500,000 mg/kg soil), for potassium (100,000 µg/l water; 1,000,000 mg/kg soil), and for sodium (100,000 µg/l water; 1,000,000 mg/kg soil). Derivations of these ADIs are provided in Appendix G. Concentrations exceeding the ADI were noted; however, since these chemicals are essential nutrients for human receptors and are unlikely to be toxic under the environmental conditions at the Site, these chemicals were not further evaluated.

Since RBCs were not available for lead, maximum detected lead concentrations in soil and sediment were compared to a residential soil screening level of 400 mg/kg (U.S. EPA, 1994d). Maximum lead concentrations in surface water were compared to water quality criteria (U.S. EPA, 1995b), while groundwater concentrations were compared to a drinking water concentration of 15 µg/l, a criterion protective of blood lead levels in children (U.S. EPA, 1991c).

In addition, two other inorganic chemicals, aluminum and iron, were eliminated as COPCs at the direction of U.S. EPA (1996d) because the RBCs were based on provisional toxicity criteria provided by the Superfund Technical Support Center and Region I does not concur with the use of these values. These metals are abundant in the earth's crust and are unlikely to cause substantial toxicity at concentrations commonly encountered.

Since the Site is largely industrial, chemicals detected in surface soil and sediment at concentrations above the residential soil RBCs were also compared to industrial soil RBCs, as shown in Tables 6-9 and 6-10. This comparison was performed for informational purposes and was not used to select COPCs.

6.2.3.2 Chemicals Selected as COPCs. This section describes the chemicals selected as COPCs and refers to lists of the selected chemicals.

COPCs in Surface Soil. Soil analytical results were evaluated for five site sample groupings and one background sample grouping, as shown in Table 6-1. The site sample groupings correspond with five areas of concern: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soil Area. Table 6-5 presents the data summary of all chemicals detected in surface soil samples for the five site sample groupings, along with a summary of the background soil sample data. The background data were compared to residential soil RBCs for informational purposes, but COPCs were not selected from the background data. Levels of arsenic and manganese detected in background surface soil exceeded residential soil RBCs. The chemicals selected as COPCs in surface soil based on comparison to RBCs are listed in Table 6-11.

COPCs in Sediment. The sediment analytical results were evaluated in three site sample groupings and one background sample grouping, as shown in Table 6-2. The three site sample groupings included West Middlesex Canal Area, Central Wetlands Area, and East Middlesex Canal and Wetlands Area. Table 6-6 presents the data summary of all chemicals detected in sediment samples for the three site sample groupings, along with a summary of the background sediment sample data. The background data were compared to residential soil RBCs for informational purposes. Volatile organic compounds, SVOCs, pesticides, PCBs, and inorganics were detected in background samples. One SVOC, benzo(a)pyrene, along with the metals, arsenic, beryllium, and manganese, were detected at maximum concentrations above the residential soil RBCs. The chemicals selected as COPCs in sediment based on comparison to RBCs are listed in Table 6-12.

COPCs in Surface Water. Surface water analytical results were evaluated in three site sample groupings and one background sample grouping, as shown in Table 6-3. The three site sample groupings included West Middlesex Canal Area, Central Wetlands Area, and East Middlesex Canal and Wetlands Area. The data summary of all chemicals detected in surface water samples for the three site sample groupings is presented in Table 6-7, along with a summary of the background surface water sample data. Five SVOCs and six pesticides were detected in background surface water. These organic compounds were detected at concentrations below the residential tap water RBCs, with the exception of one SVOC, benzo(b)fluoranthene, which exceeded the tap water RBC. Of the metals detected in background surface water, arsenic, barium, beryllium, chromium, manganese, thallium, and vanadium were detected at concentrations above the tap water RBCs. There is no Region III RBC for lead, but lead was selected as a COPC in surface water because it was detected at concentrations above the water quality criterion for ingestion of water and organisms. The chemicals selected as COPCs in surface water based on comparison to tap water RBCs are listed in Table 6-13.

Although essential nutrients were not selected as COPCs, sodium was detected at a maximum concentration in excess of the ADI in the surface water of both the Central Wetlands Area and East Middlesex Canal and Wetlands Area. The maximum potassium concentration detected in the East Middlesex Canal and Wetlands Area exceeded the ADI for potassium.

COPCs in Groundwater. Groundwater analytical results were evaluated in five site sample groupings and one background sample grouping, as shown in Table 6-4. The site sample groupings corresponded to five areas of concern: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons. The data summary of all chemicals detected in groundwater samples for the five site sample groupings is presented in Table 6-8, along with a summary of the background groundwater sample data. In shallow overburden groundwater, Aroclor-1260 was detected above the tap water RBC, but below the MCL. Manganese also exceeded the manganese RBC in shallow overburden background groundwater. In deep overburden groundwater, only arsenic exceeded its tap water RBC. In bedrock groundwater, Aroclor-1260 and arsenic were detected at concentrations exceeding tap water RBCs. The chemicals selected as COPCs in groundwater based on comparisons to RBCs are listed in Table 6-14.

Although essential nutrients were not selected as COPCs, concentrations that exceeded the ADIs were noted. Sodium was detected at maximum concentrations which exceeded the ADI of 100,000 $\mu g/l$ in the following groundwater flow zones: the B&M Railroad Landfill shallow overburden, the B&M Locomotive Shop Disposal Area bedrock, the Old B&M Oil/Sludge Recycling Area bedrock, the RSI Landfill shallow overburden, and the Asbestos Lagoon deep overburden and bedrock. In both the RSI Landfill deep overburden and bedrock wells, sodium and calcium were detected at maximum concentrations that exceeded the relevant ADI.

6.2.4 Determination of Exposure Point Concentrations

To evaluate the magnitude of potential human exposures, the concentration of each COPC in each exposure medium must be estimated. An estimate of this concentration is referred to as an exposure point concentration. Exposure point concentrations were determined for the COPCs in each medium.

The approach used to estimate exposure point concentrations followed EPA (1989g; 1992h; and 1994e) guidance. According to this guidance, EPA requires the use of the 95% upper confidence limit (UCL) on the arithmetic mean concentration for the estimation of both the central tendency and RME risk. The methodology for calculating the UCL for the lognormal distribution, discussed by Gilbert (1987) and Land (1975) and presented in U.S. EPA (1992g and h), is as follows:

$$UCL_{1-\alpha} = \exp\left(y + 0.5(s_y)^2 + \frac{s_y(H_{1-\alpha})}{\sqrt{n-1}}\right)$$

where:	UCL	=	upper confidence limit;
	α	=	probability of error (0.05);
	y	=	mean of the transformed data;
	$(s_y)^2$	=	variance of the transformed data;
	s_y	=	standard deviation of the transformed data;
	H	=	H-statistic (Gilbert 1987); and
	n	=	number of samples in the population.

The 95% UCL concentration was used to calculate exposures unless it exceeded the maximum detected value, in which case EPA (1989g and 1994e) directs that the maximum detected value be used as the exposure point concentration. Tables 6-15, 6-16, and 6-17 list the arithmetic mean, maximum detected concentration, the 95% UCL, and the exposure point concentration for each COPC by media in surface soil, sediment, and surface water, respectively.

Exposure point concentrations for COPCs in groundwater were determined in a slightly different manner (Table 6-18). The arithmetic mean concentration for each COPC was used in calculating the central tendency exposure, and the maximum concentration was used to calculate the RME exposure, rather than using the 95% UCL (U.S. EPA, 1994e). In the event that the arithmetic mean exceeded the maximum detected concentration, the maximum detected concentration was used for the central tendency exposure.

6.3 HUMAN EXPOSURE ASSESSMENT

The purpose of the human exposure assessment is the quantification of the extent, frequency, and duration of actual or potential exposure to chemicals by pathways relevant to the Site and activities of the potential receptors.

6.3.1 Identification of Potential Exposed Populations and Potential Exposure Pathways

As part of the exposure assessment, potential current and future exposure pathways were determined through which identified populations may be exposed to the COPCs at the Site.

An exposure pathway describes the course a chemical follows while moving through environmental media from its source to the receptor. An exposure pathway may consist of the following elements: 1) a source; 2) a mechanism of release from the source into the environment; 3) an environmental transport medium (e.g., groundwater); 4) an exposure route (e.g., ingestion); and 5) a receptor. An exposure pathway is considered complete when all five elements are present. For purposes of this risk assessment, only potentially complete exposure pathways were quantitatively evaluated.

The EPA (1989g and 1991b) guidance requires that plausible exposures under both current and future land-use scenarios be evaluated in a baseline risk assessment. Accordingly, potential human exposure pathways were identified for both current and potential future land-use scenarios at the Site. The current land-use scenarios examine the potential for human exposure under current site conditions, while the future land-use scenario evaluates potential exposures following possible changes in site use (assuming no remedial action occurs).

6.3.1.1 Potential Exposure Pathways and Receptors Under Current Land-Use Conditions

Fences and signs discourage access to the Site by trespassers; however, it is possible for trespassers to enter the Site. Therefore, exposures to trespassers were evaluated. For the trespasser scenario, a child/teenager (i.e., 7 to 16 years old) was considered as the receptor population.

Surface Soil Pathways. Surface soil samples were collected from five areas of concern at the Site: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soil Area. Site workers as well as trespassers could potentially contact surface soil from any of these areas; therefore, exposures of both site workers and trespassers to surface soil through incidental ingestion and dermal contact of COPCs in surface soil were evaluated.

Sediment and Surface Water Pathways. Sediment and surface water samples were grouped into three areas: West Middlesex Canal Area, Central Wetlands Area, and East Middlesex Canal/Wetlands Area. Since industrial operations at the Site would result in little, if any, contact by site workers with sediment and surface water in the wetlands or water bodies at the Site, exposures of workers to sediment and surface water were not evaluated.

However, trespassers could play in the wetlands or along the water bodies at the Site; therefore, exposures of child/teenage trespassers to sediment and surface water will be evaluated. Since most of the water bodies are shallow, swimming would not be likely to occur. Therefore, trespassers were assumed to wade, rather than swim. Exposure pathways associated with wading that were evaluated include incidental ingestion of and dermal contact with sediment and dermal contact with surface water. The ingestion of surface water was not assessed since the water is shallow, making it unlikely that a trespasser would ingest more than a negligible amount.

Groundwater Pathways. Groundwater samples were collected from monitoring wells associated with each of the five areas of concern. Although COPCs were detected in groundwater from monitoring wells, groundwater occurring at the Site is not currently an exposure medium because it is not used for drinking water or other purposes. Since water is supplied to the Site from alternative sources, it is not likely that any receptors would contact groundwater at the Site. Therefore, exposures to COPCs in groundwater were not assessed under current land-use conditions.

6.3.1.2 Potential Receptors and Exposure Pathways Under Future Land-Use Conditions. To evaluate potential future exposures, it was assumed that no remedial action was taken, and that the levels of contamination currently existing at the Site would remain the same in the future. There are two potential options for future land use: continued industrial use and residential development. Both the Billerica Planning Board and the MADEP were consulted on this matter and both indicated that future land use is expected to be industrial (U.S. EPA, 1996e). Under these conditions, the exposures described under current land-use conditions for site workers and trespassers are likely to remain unchanged in the future; therefore, the exposure pathways for these receptors were not re-evaluated under future land use conditions.

EPA Region I has requested that future potential residential use of groundwater from the Site be evaluated. Exposures of future area residents to COPCs in groundwater underlying the Site could occur under future land-use conditions if groundwater were used for drinking water. Therefore, it was assumed that future area residents would use groundwater with a composition represented by groundwater from the monitoring wells sampled during the RI. Routes of exposure associated with residential groundwater use may include ingestion of drinking water, inhalation of chemicals that have volatilized from groundwater during use (e.g., while showering), and dermal contact with groundwater during use (e.g., while bathing). Drinking water ingestion exposures of residents were quantitatively evaluated. Potential exposures from other pathways, such as inhalation or dermal contact during bathing, are addressed in section 6.5.3.4, exposure assessment uncertainties.

6.3.1.3 Summary of Pathways and Receptors Selected for Consideration. The following items summarize the pathways evaluated for each exposure scenario.

- Site adult worker scenario, current and future
  Ingestion pathways: surface soil

Dermal contact pathways: surface soil

- Site child/teenager trespasser scenario, current and future
  Ingestion pathways: surface soil, sediment
  Dermal contact pathways: surface soil, sediment, surface water

- Residential scenario, future
  Ingestion pathways: groundwater

6.3.2 Calculation of Dose

The purpose of the exposure assessment is to identify exposure equations and toxicity factors to be used in the risk assessment and to document assumptions made for each of the parameters used in these equations. EPA Region 1 *Risk Updates* (U.S. EPA, 1994e) requires the calculation of central tendency exposure and RME estimates and provides default exposure parameters for each of these estimations. The risk assessment used the default central tendency exposure parameters to evaluate average exposures and high-end exposure parameters to calculate RME estimates. For exposure parameters that are not available from this source, other EPA guidance documents were used, including *Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessment* (*Statistical Distributions*) (U.S. EPA, 1985b); *RAGS* (U.S.EPA, 1989g); *Standard Default Exposure Parameters* (U.S. EPA, 1991b); and *Dermal Exposure Assessment: Principles and Applications* (*Dermal Guidance*) (U.S. EPA, 1992b).

6.3.2.1 Selection of Exposure Equations. Two equations are presented for each pathway: one for calculating a lifetime average daily dose (LADD) relevant to cancer risk; the other for calculating an average daily dose (ADD) relevant to noncancer risk. The media-specific equations used for the calculation of carcinogenic and noncarcinogenic doses of the COPCs are presented in Tables 6-19 to 6-25. Additional equations used in calculating dose following dermal exposure to organics in surface water are contained in Appendix G.

6.3.2.2 Exposure Parameters. The exposure parameters used for each of the receptors evaluated in the risk assessment are described below and are presented in Tables 6-19 through 6-25. Since exposure parameters vary depending on the exposure pathway and receptor being evaluated, the exposure parameters are presented by pathway in the tables and are discussed by receptor.

Site Adult Worker Exposure Parameters. As shown in Tables 6-23 and 6-24, the exposure parameters for worker exposures primarily rely on default central tendency and high-end exposure parameters presented in *Risk Updates* (U.S. EPA, 1994e). For the soil ingestion pathway, the default central tendency and high-end soil ingestion rates for noncontact workers were used, since operations at the Site do not typically involve contact-intensive activities (e.g., construction, excavation). The recommended exposure frequency of 150 days/year for workers was used for the central tendency and RME cases. The default high-end exposure duration of 25 years was used for the RME case, while an average employment duration of 15 years, described in a Bureau of Labor Statistics newsletter on occupational mobility (BLS, 1987), was used for the central tendency exposure case. The default value of 70 kg for an adult body weight was used for both central tendency and high-end exposures. Finally, as recommended in *RAGS* (U.S. EPA, 1989g), the averaging time for noncarcinogens was set equal to the exposure duration, and the carcinogenic lifetime averaging time of 70 years was used.

For the dermal pathway, skin surface areas were calculated for the body parts that could contact soil, using statistical distributions of surface areas provided in the *Statistical Distributions* report (U.S. EPA, 1985b). Workers were assumed to contact soil with 25% of their body for a surface area 5,000 cm^2 for the central tendency case and 5,800 cm^2 for the RME case. From the range of soil-to-skin adherence factors provided in *Dermal Guidance* (U.S. EPA, 1992b), adherence factors of 0.2 and 1.0 mg/cm^2 were used for the central tendency exposure and RME cases, respectively. The only COPCs in surface soil for which a chemical-specific dermal absorption factor was recommended in *Dermal Guidance* (U.S. EPA, 1992b) was cadmium. The range of dermal absorption factors given for cadmium was 0.1% to 1%; to be conservative, 1% was used in both the central tendency and RME cases. In the absence of recommended dermal absorption factors, dermal exposures to the remaining COPCs were not assessed. The remaining exposure parameters used for the dermal exposure pathway (i.e., exposure frequency, exposure duration, body weight, and averaging time) were the same as the values described for the soil ingestion pathway.

Trespasser Exposure Parameters. Since the child/teenage trespasser age range of 7 to 16 years falls between the receptor groups (i.e., child and adult) presented in the *Risk Updates* (U.S. EPA, 1994e) guidance, many of the exposure parameters for the trespasser group were selected based on professional judgement, while others were determined given site-specific information. Exposure frequency and duration were estimated given site-specific conditions, rather than using a default scenario. Default assumptions were used for body surface area and soil adherence factors. Exposure parameters are shown in Tables 6-19 through 6-22 and are discussed for trespasser contact with surface soil, sediment, and surface water.

The default central tendency and high-end soil ingestion rates of 50 and 100 mg/day were used for trespassers, in accordance with *Standard Default Exposure Factors* (U.S. EPA, 1991b), which applies these values to individuals older than 6 years old. The default soil ingestion rates were used to evaluate sediment contact rates associated with recreational activities. Since the weather in the area surrounding the Site is cold and not conducive to outdoor activities for about 6 months of the year, it was assumed that the trespasser may venture onto the site 1 or 2 days per week for 6 months of the year. Therefore the exposure frequency values used for the central tendency and RME exposure cases were 26 and 52 days/year, respectively. The exposure duration of 10 years for the RME case assumed that the receptor would trespass onto the Site every year within the given age range, while the receptor was assumed to trespass 5 years for the central tendency exposure case. The body weight for the child/teenager (45 kg) that was used for both the RME and central tendency cases was consistent with age-specific data presented in *Statistical Distributions* (U.S. EPA, 1985b). Finally, the standard EPA lifetime averaging time for carcinogens, 70 years, was used, and for noncarcinogens, the exposure duration was used as the averaging time (U.S. EPA, 1989g).

For the surface soil and sediment dermal exposure pathways, additional dermal parameters were used from *Dermal Guidance* (U.S. EPA, 1992b), including the soil-to-skin adherence factor and chemical-specific dermal absorption factors. From the range of soil-to-skin adherence factors provided in *Dermal Guidance* (U.S. EPA, 1992b), adherence factors of 0.2 and 1.0 mg/cm^2 were used for the central tendency exposure and RME cases, respectively. The only COPCS in surface soil or sediment for which a chemical-specific dermal absorption factor was recommended in *Dermal Guidance* (U.S. EPA, 1992b) was cadmium. The range of dermal absorption factors given for cadmium was 0.1% to 1%; to be conservative 1% was used in both the central tendency and the RME cases. In the absence of recommended dermal absorption factors, dermal exposures to the remaining COPCs were not assessed. In determining skin surface areas, trespassers were assumed to contact soil and sediment with 25% of their body surface area, with amounts to 4,100 cm^2 for RME exposure and 3,300 cm^2 for central tendency exposure. The same exposure frequency, exposure duration, body weight, and averaging time parameters used for the soil and sediment ingestion pathways were used for the dermal exposure pathways for contact with surface soil and sediment.

For the surface water dermal exposure pathway, absorbed doses were calculated for each chemical using equations and chemical-specific factors provided in *Dermal Guidance* (U.S. EPA, 1992b) as well as the EPA electronic spreadsheet file (U.S. EPA, 1993g). The dermal absorbed dose was calculated using chemical permeability coefficients and, for organic compounds, molecular weight and octanol-water partition coefficients, as detailed in Appendix G. For this exposure, event times of 1 hour and 2 hours were assumed for the central tendency exposure and RME cases, respectively. In determining skin surface areas, trespassers were assumed to contact surface water with 25% of their body surface area, which amounts to 3,300 cm^2 for central tendency exposure and 4,100 cm^2 for RME. The same exposure frequency, exposure duration, body weight, and averaging time parameters used for the soil and sediment pathways were used for the dermal exposure pathway for contact with surface water.

Residential Exposure Parameters. The exposure parameters proposed for residential exposures, as shown in Table 6-25, rely primarily on default central tendency and high-end exposure parameters from the *Risk Updates* (U.S. EPA, 1994e). For the groundwater ingestion pathway, the default central tendency and high-end exposure parameter values describing drinking water ingestion rate, exposure frequency, exposure duration, and body weight were obtained from the *Risk Updates* (U.S. EPA, 1994e). As recommended in *RAGS* (U.S. EPA, 1989g), the averaging time for noncarcinogens was set equal to the exposure duration (30 years), and the averaging time for carcinogens was the standard EPA lifetime duration (70 years).

6.4 TOXICITY ASSESSMENT

The toxicity assessment presented here was conducted in accordance with EPA guidance (1989g). The methodology used for classifying health effects from exposure to chemicals is recommended by EPA (1986c,d; 1989g). The health effects analysis considers chronic (long-term) exposures. For potentially carcinogenic chemicals, less than chronic exposures would result in less risk than chronic exposure; therefore, if chronic risk is acceptable, risk from subchronic exposures will also be acceptable. For noncarcinogenic chemicals, acute and subchronic hazards could be assessed; however, only irritating substances such as sulfur dioxide would likely present an acute hazard. Chronic exposures would result in higher hazards than subchronic exposures; therefore, again, if chronic HIs are acceptable, subchronic indices are also acceptable.

The chronic toxicity criteria were obtained from EPA's Integrated Risk Information System (IRIS) (U.S. EPA, 1996c) and Health Effects Assessment Summary Tables (HEAST) (U.S. EPA, 1995a). These sources list the most recent toxicity values recommended by EPA for use in human health risk assessments. In addition, some toxicity criteria values were obtained from the National Center of Environmental Assessment, a division of EPA.

Since no toxicity criteria values are available for lead, lead toxicity is assessed using an interim approach recommended for use with non-residential adult exposures, as discussed in section 6.4.4.

6.4.1 Toxicity Information for Carcinogenic Effects

The potential for human carcinogenic effects is evaluated based on the chemical-specific slope factors (SFs) and the weight-of-evidence classification of the EPA. The SF is the toxicity value that quantitatively defines the dose-response relationship of a known or suspected carcinogen. The SF is an estimate of an upper-bound lifetime probability of an individual developing cancer following exposure to a potential cancer-causing agent over his or her lifetime. The SFs for chemicals are generally expressed as the 95% UCL of the slope of the dose-response curve and are derived by assuming low-dose linearity and applying a computer model to extrapolate from the relatively high doses administered to animals (or the exposures observed in epidemiological studies) to the lower environmental exposure levels that generally occur in humans. The EPA has developed SFs for chemicals classified as carcinogens, based on the premise that there is no threshold, i.e., there is no level of exposure below which there is no risk of a carcinogenic effect.

Because the SF is generally the 95% UCL of the probability of a response per unit intake of a chemical over a lifetime exposure, the use of such SFs is expected to result in a conservative (i.e., upper-bound) estimate of potential cancer risk. The true risk to humans is not likely to exceed the upper-bound estimate but could be lower and may even be zero. Further, because the dose-response curve is assumed to be linear in the low-dose region, the accuracy of the SF may be limited if this region should, in reality, exhibit nonlinearity.

Table 6-26 summarizes the carcinogenic toxicity values (i.e., SFs) and the corresponding weight-of-evidence classifications. Additional discussion on each COPC is provided in Appendix G.

6.4.2 Toxicity Information for Noncarcinogenic Effects

Systemic toxic effects other than cancer can be associated with exposures to chemicals. The reference doses (RfDs) are the toxicity values that are used to evaluate the potential of developing noncarcinogenic effects as a result of exposure to potentially toxic chemicals. The RfDs have been developed on the premise that there are protective mechanisms that must be overcome before an appreciable risk of adverse health effects is manifested during a defined exposure period. It is assumed that there is a threshold dose that must be exceeded before adverse effects can occur.

Chemicals classified as carcinogens may also produce other systemic effects. These chemicals were also evaluated for potential noncarcinogenic toxic effects and were included in the determination of chronic toxicity HIs, which characterize noncancer hazards. Carcinogenic effects, however, are usually manifested at levels that are significantly lower than those associated with systemic toxic effects; thus, cancer is usually the predominant adverse effect for contaminants that may elicit carcinogenic as well as noncarcinogenic responses.

Table 6-26 summarizes the noncarcinogenic toxicity values (i.e., RfDs) and the corresponding critical effects for the COPCs at the Site. Additional information on the noncarcinogenic effects for each COPC is presented in the toxicity profiles in Appendix G.

6.4.3 Adjustment of Toxicity Factors

No RfDs or SFs are available for evaluating dermal exposure. Therefore, risks and HIs associated with dermal exposure may be evaluated using an oral SF or RfD. As detailed in U.S. EPA (1989g), for purposes of evaluating dermal exposure, it is generally necessary to adjust an oral toxicity factor (i.e., RfD or SF) from an administered to an absorbed dose. Because the toxicity values for the COPCs at the site are expressed as orally administered doses (i.e., intake-based), it is necessary to adjust both the RfDs and SFs for these substances in estimating exposure on an absorbed-dose basis when assessing dermal exposure.

The oral RfDs and oral SFs for each COPC were modified according to the following equations (U.S. EPA, 1989g) for use in assessing dermal exposure:

$$ERfD_o = RfD_o \times BF_{o,a}$$
$$ESF_o = SF_o / BF_{o,a}$$

where:

$ERfD_o$	=	effective absorbed-dose oral RfD for each chemical
RfD_o	=	oral RfD for each chemical
$BF_{o,a}$	=	absolute oral bioavailability factor for each chemical
ESF_o	=	effective absorbed-dose oral SF for chemical
SF_o	=	oral SF for each chemical

Table G-3-1 presents the absolute oral bioavailability fractions used to adjust the oral toxicity criteria for the COPCs evaluated in the dermal exposure pathways. Most values were derived from data presented in the Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile documents. The cadmium absolute oral bioavailability factors were taken from IRIS (U.S EPA, 1996c): 2.5% was used for aqueous exposures and 5% was used for nonaqueous exposures. In the case of chemicals for which sufficient information was lacking, a default absolute oral bioavailability factor of 100% (1.0) was used.

6.4.4 Toxicity of Lead

No RfD or SF are available for lead, a common environmental contaminant. The EPA has recommended some interim approaches to evaluating exposures to lead, to be used in lieu of the approaches described above for carcinogenic and noncarcinogenic effects. The approach most relevant to the Site is a method for assessing risks associated with non-residential adult exposures to lead in soil. The method (U.S. EPA, 1996g) relates soil lead intake to blood lead concentrations in women of childbearing age; this group is assumed to be the most sensitive to lead exposure, among adults. The method does not provide a quantitative estimate of risk; instead it predicts a central estimate of blood lead concentrations in women of child-bearing age that have exposures to soil lead at site concentrations. This concentration can then be compared to a goal structured so that the 95th percentile blood lead concentration among fetuses born to women exposed at the Site is expected to be below a specified risk-based limit for fetuses. The goal for the central estimate of blood lead concentration (in micrograms of lead per deciliter of blood, or µg/dL) in adults that have site exposures is calculated as follows (U.S. EPA, 1996g):

$$Pb(B)_{adult,\ central,\ goal} = \frac{Pb(B)_{fetal,\ 0.95,\ goal}}{GSD^{1.645}\ x\ R}$$

where:

$Pb(B)_{fetal,\ 0.95,\ goal}$	=	goal for the 95th percentile blood lead concentration among fetuses
GSD	=	estimated geometric standard deviation in intake and biokinetics among women with similar on-site lead exposures
R	=	ratio of fetal blood lead concentration to maternal blood concentration

The value selected for $Pb(B)_{fetal,\ 0.95,\ goal}$ is 10 µg/dL based on current EPA guidance calling for cleanup goals that limit childhood risk of exceeding 10 µg/dL to five percent; the value selected for GSD is 1.8, which is typical of populations in small areas that are dominated by a single source of lead exposure, and that are relatively homogeneous with respect to socioeconomic and ethnic characteristics; and R is assumed to be 0.9, based on studies of the relationship between umbilical cord and maternal blood lead concentrations (U.S. EPA, 1996g). Based on these values, the goal for the central estimate of blood lead concentration in adults is 4.2 µg/dL for the Site. Predicted blood concentrations are compared to this value in the section 6.5, based on site surface soil concentrations.

6.5 RISK CHARACTERIZATION

Risk characterization combines estimates of exposure with toxicity data to develop estimates of the probability that an adverse effect will occur under the specified conditions of exposure. The risk characterization was divided into three subphases: 1) risk estimation, 2) risk description, and 3) uncertainty analysis.

Risk estimation is undertaken by combining the toxicity factors and exposure assessment equations to calculate estimates of risks. Estimates of carcinogenic risks are reported as incremental (above background) lifetime cancer incidence risks (ILCRs). Noncarcinogenic risks are reported as pathway-specific hazard quotients (HQs) or HIs, which are the sum of pathway-specific HQs. Risks associated with lead are reported as a central estimate of blood lead concentration in adults. Risk description entails several discussions, including the relative contributions of individual exposure pathways to the total risk for each medium. The significance of the risk estimates are relative to action levels set forth in EPA policy (i.e., an ILCR above 10^{-6} to 10^{-4} and an HI above 1.0). The uncertainty analysis describes and quantifies, where possible, the impact of data, assumptions, and parameter values on estimates of risk.

6.5.1 Risk Estimation

The cancer risk of each receptor is estimated for each medium by means of an ILCR. For comparison, the background lifetime cancer risk in North America is about 2.5×10^{-1}. While a 1×10^{-6} ILCR is generally considered to be EPA's benchmark, an ILCR range of 1×10^{-4} to 1×10^{-6} is used by EPA at Superfund sites in the evaluation of remedial alternatives and is considered to be an acceptable risk range (U.S. EPA, 1990b). U.S. EPA's Office of Solid Waste and Emergency Response (OSWER) has issued further guidance clarifying the role of risk assessment in the Superfund process (U.S. EPA, 1991c). This directive states that where the cumulative incremental current or future carcinogenic risk to an individual is less than 10^{-4}, and where the noncarcinogenic HQ is less than 1, action generally is not warranted unless there are adverse environmental impacts.

The EPA generally regards an ILCR, attributable to human-caused releases of chemicals classified as carcinogenic substances into the environment, in excess of 10^{-4} as unacceptable; however, the agency retains the right to lower the acceptable incremental risk on a site-specific basis to 10^{-6}. To calculate ILCR, the chemical- and pathway-specific LADDs, calculated as described in section 6.3.2, were multiplied by SFs as follows:

$$\text{ILCR} = \text{SF} \times \text{LADD}$$

The resulting value represents the upper-bound probability that an individual could develop cancer over his or her lifetime due to exposure to potential carcinogens under the conditions specified in the exposure scenario. For example, a carcinogenic risk level of 1×10^{-6} represents a one in one million chance that an individual could contract cancer over a lifetime. Total excess cancer risks for each pathway were calculated by summing the risks from each chemical in each area within the pathway, while total risks for each medium within each receptor were calculated by summing ILCRs for each pathway within the medium. Sampling was conducted, as previously described, at various areas around the Site. For example, soil samples were taken from five areas of concern including the B&M Railroad Landfill. Total cancer risk to a trespasser from exposure to soil in the area of the B&M Railroad Landfill was determined by adding the risk from soil ingestion to the risk from dermal contact with soil from this area. Therefore, for each receptor, cancer risk from each medium is presented by area of concern. Risk was not summed across areas since the parameter values used assume maximal exposure within each area of concern. It is assumed that an individual would not be maximally exposed to soil in both the B&M Railroad Landfill and RSI Landfill Areas.

Noncancer risk is estimated by means of a HQ. To calculate noncarcinogenic HQs, the ADDs, calculated as described in section 6.3.2, were divided by the RfDs as follows:

$$HQ = ADD / RfD$$

The sum of this ratio for all chemicals within an area and pathway that have the same target organ or type of toxicity is termed the HI. The HI is useful as a reference point for gauging potential effects of environmental exposures to complex mixtures. The EPA interprets a HI greater than unity (1) to be an indicator of potential toxic effects. In general, HIs that are less than 1 are not of regulatory concern; however, a HI of greater than 1 does not automatically indicate that an adverse effect will occur and should not automatically be interpreted as posing a hazard to the exposed population. The pathway totals for HQ for each area within a pathway were calculated by summing the HQs for COPCs having similar systemic effects for noncancer risks. Total HQs for each receptor, by medium, were calculated by summing the total pathway HQs across pathways within the media. Within each medium and pathway, as a first approximation, all COPCs are assumed to have additive effects. However, in cases where the HI exceeded 1, only COPCs having similar systemic effects were summed for each pathway and medium.

Risks associated with lead are described by comparing the central estimate of blood lead concentration in women of childbearing age to a goal blood lead concentration associated with a fetal blood lead concentration of 10 μg/dL. The central estimate of blood lead concentration in these adults is calculated as:

$$Pb(B)_{adult,\ central} = Pb(B)_{adult,\ 0} + \frac{Pb(S)\ x\ BKSF\ x\ IR_S\ x\ AF_S\ x\ EF_S}{AT}$$

where:

$Pb(B)_{adult,0}$	=	typical blood lead concentration in women of childbearing age in the absence of site exposures (μg/dL)
Pb(S)	=	soil lead exposure point concentration in μg/g (mg/kg)
BKSF	=	biokinetic slope factor relating quasi-steady state adult blood lead concentration to average daily lead uptake (μg/dL per μg/day)
IR_S	=	intake rate of soil, including both outdoor soil and indoor soil-derived dust (g/day)
AF_S	=	absolute gastrointestinal absorption fraction for ingested lead in soil and soil-derived dust (unitless)
EF_S	=	exposure frequency (days/year)
AT	=	averaging time, selected as 365 days/year for long-term exposures

A typical blood lead concentration in women of child-bearing age in the absence of site exposures is assumed to be 1.7 μg/dL, which is a low end default assumption (U.S. EPA, 1996g). The biokinetic slope factor for lead is assumed to be 0.4 μg/dL per μg/day (U.S. EPA, 1996g). A representative intake rate of soil is assumed to be 0.05 g/day based on occupational, indoor exposures to dust from outdoor soil (50 mg/day; U.S. EPA, 1996g). The absolute gastrointestinal absorption fraction for ingested lead in soil and soil-derived dust is assumed to be 0.12 (U.S. EPA, 1996g). Following EPA default assumptions for evaluating lead exposures (U.S. EPA, 1996g), the exposure frequency is assumed to be 219 days per year. Estimated blood levels are compared to the goal of 4.2 μg/dL which was determined in section 6.4.4.

6.5.2 Risk Description

This section summarizes the human health risks potentially associated with exposures to environmental media (soil, sediment, surface water, and groundwater). Individual chemical-specific carcinogenic risks are expressed as probabilities of contracting cancer, while noncarcinogenic risks are expressed as HQs. All carcinogenic and noncarcinogenic risks were calculated using both the central tendency and RME methods. RME estimates are considered to be conservative bounding estimates of risk. Therefore, if the RME cancer risk estimate for a pathway was less than 1×10^{-6}, and the noncarcinogenic HI was less than 1, the pathway was determined not to be of concern with respect to human health.

The risk description for the Site is provided below in two parts. First, the relative contributions of the various exposure pathways within each medium are analyzed for each receptor. Second, the relative contributions of each contaminant are analyzed for each receptor. The carcinogenic and noncarcinogenic risks associated with each medium for the trespasser, site worker, and resident scenarios are presented in Tables 6-27 to 6-43. An evaluation of risks to a site worker from lead is presented in Table 6-44.

Exposure Pathway Contribution Analysis. The estimated risks, for both the central tendency and RME cases, are summed across pathways for each chemical evaluated within each medium. The RME estimates are conservative for two reasons. First, estimated risks for each pathway are based on upper-bound exposure. Second, the risks can be compounded by assuming that estimated risks for each chemical in a pathway is based on upper-bound assumptions regarding exposure, along with the added conservatism that an individual is exposed by all pathways within an area and medium. For example, the RME individual was assumed to be exposed to all chemicals present in the soil in the B&M Railroad Landfill by both incidental ingestion and dermal contact.

6.5.2.1 Description of ILCR Estimates. Estimates of ILCR represent the risk of cancer from the Site, as described in Section 6.5.1.

Trespasser Receptor. The estimated ILCRs for exposure pathways assessed for each medium for the trespasser receptor are listed, by chemical and pathway, in Tables 6-27, 6-31, and 6-35. The trespasser receptor is assumed to trespass on the Site 26 to 52 times per year for 5 to 10 years while between the ages of 7 and 16. Uncertainty associated with these assumptions is discussed in section 6.5.3. As such, the trespasser is conservatively assumed to be exposed to site contaminants through dermal contact with soil, sediment, and surface water, and through the incidental ingestion of soil and sediment.

Some ILCRs for the soil and sediment ingestion and dermal contact were estimated to be above 10^{-6}, but all estimates were below 10^{-5}. The addition of risks from soil and sediment ingestion to those from dermal contact for each area of concern was not an issue since no carcinogens were assessed for dermal contact with soil and sediment, due to the lack of recommended dermal absorption values (U.S. EPA, 1992b). The highest risk following the incidental ingestion of soil by the RME trespasser was 8.46×10^{-6}, for the RME individual in the B&M Railroad Landfill (Table 6-27). The largest contributors to risk in this area were benzo(a)pyrene and arsenic, which contributed 44% and 22% of the total risk, respectively. The highest risk following the incidental ingestion of sediment by the RME trespasser was 5.24×10^{-6}, for the RME individual in the East Middlesex Canal and Wetlands Area (Table 6-31). The largest contributors to the sediment ingestion risk in this area were arsenic and benzo(a)pyrene.

The ILCRs for surface water dermal contact were also estimated to be above 10^{-6} but below 10^{-4} (Table 6-35). The highest risk to the RME trespasser, associated with dermal contact with surface water, was 4.46×10^{-6} in the East Middlesex Canal and Wetlands Area. The largest contributor to this risk was arsenic (99% of the risk estimate).

Site Adult Worker Receptor. The estimated ILCRs for exposure pathways assessed for each medium for the site worker receptor are listed, by chemical and pathway in Table 6-37. The site occupational receptor is assumed to contact site soil 150 days per year for 15 to 25 years. Uncertainty associated with these assumptions is discussed in section 6.5.3. The site worker is conservatively assumed to be exposed to site contaminants through dermal contact with and incidental ingestion of soil.

Some ILCRs for soil ingestion were estimated to be above 10^{-6}, but all estimates were below 10^{-4}. The addition of risks from soil ingestion to those from dermal contact for each area was not an issue since no carcinogens were assessed for dermal contact, due to the lack of recommended dermal absorption values (U.S. EPA, 1992b). The highest ILCR for the ingestion of soil for the RME worker was 3.92×10^{-5} (B&M Railroad Landfill), with benzo(a)pyrene contributing 44% of the risk.

Future Adult Resident Receptor. The estimated ILCRs for exposure pathways for the ingestion of groundwater by the future adult resident receptor are listed in Table 6-41, by chemical and area of concern. The adult resident receptor is assumed to drink the groundwater 350 days per year for 9 to 30 years. Uncertainty associated with these assumptions is discussed in section 6.5.3.

Three flow zones at five areas of concern were evaluated, for a total of 15 groups. All ILCRs for this groundwater pathway exceeded 1×10^{-6} for both the central tendency and RME cases. In 12 of the 15 groups, the ILCRs for the RME individual exceeded 1×10^{-4}, while in two of the groups (RSI Landfill shallow and deep overburden wells), the central tendency individual also exceeded 1×10^{-4}. In the RSI Landfill shallow and deep overburden wells and the Asbestos Lagoon shallow overburden wells, the ILCRs for the RME individual exceeded 1×10^{-3}. For these three groups, risks to the RME individual were estimated to be 3.40×10^{-3}, 6.09×10^{-3}, and 1.03×10^{-3}, respectively. Risks to the central tendency individuals were estimated to be 1.50×10^{-4}, 2.56×10^{-4}, and 6.95×10^{-5}, respectively. Arsenic was the main contributor to risk in each case.

Other wells with ILCRs in excess of 1×10^{-4} for the RME individual were the B&M Railroad Landfill shallow overburden (9.86×10^{-4}) and bedrock (4.27×10^{-4}); the RSI Landfill bedrock (2.35×10^{-4}); the B&M Locomotive Shop Disposal Area deep overburden (2.93×10^{-4}); the Old B&M Oil/Sludge Recycling Area shallow overburden (4.79×10^{-4}), deep overburden (1.31×10^{-4}), and bedrock

(1.69×10^{-4}); and the Asbestos Lagoon deep overburden (4.32×10^{-4}) and bedrock (1.53×10^{-4}). Arsenic was the main contributor to risk in each of these wells, except in Asbestos Lagoon bedrock, where beryllium was the main contributor.

6.5.2.2 Description of HI Estimates. Estimates of HIs represent the risk of health effects other than cancer from the Site, as discussed in section 6.5.1.

Trespasser Receptor. The estimated HIs for each pathway and medium are listed in Tables 6-28, 6-29, 6-32, 6-33, and 6-36. HIs for soil and sediment ingestion and dermal contact were less than 1 even when added within an area of concern, as described in Tables 6-30 and 6-34. The highest HI for soil ingestion and dermal absorption was 0.18 for the RME individual in the B&M Railroad Landfill (Table 6-30). The area of the Site with the highest HI from contact with sediment was the West Middlesex Canal Area, with an HI of 0.069 for the RME individual (Table 6-34).

The HIs for surface water dermal contact were all well below 1. The highest was 0.15, for the RME individual in the East Middlesex Canal and Wetlands Area (Table 6-36). The largest contributors were arsenic and manganese.

Site Adult Worker Receptor. The HIs are listed by medium, pathway, and chemical in Tables 6-38 and 6-39. All estimated HIs for soil ingestion and dermal contact were below 1. The highest HI for soil ingestion plus dermal contact by the RME site worker was 0.41 for the B&M Railroad Landfill (Table 6-40).

Future Adult Resident Receptor. The HIs for groundwater ingestion are listed by area of concern and chemical in Table 6-42. The estimated HIs exceeded 1 for all 15 groups in the RME case and 7 of the 15 groups in the central tendency case. Because total HIs in these areas exceeded 1, the HIs were re-totaled, adding only chemicals having a similar target organ or critical effect. In all but one case (the RME estimate for the B&M Locomotive Shop Disposal Area bedrock well), the HIs still exceeded 1. These target organ-specific HIs are listed in Table 6-43.

6.5.2.3 Risks Associated with Adult Exposure to Lead. Lead is a COPCS in surface soil in the B&M Railroad Landfill, the B&M Locomotive Shop Disposal Area, and the Contaminated Soil Area. The calculated central estimates of blood lead concentration in women of childbearing age exceed the goal of 4.2 µg/dL for the B&M Locomotive Shop Disposal Area and the Contaminated Soil Area overall, as shown in Table 6-44.

There is a wide range of lead concentrations in the Contaminated Soil Area and the locations of high concentrations are not evenly distributed. Most of the higher concentrations are located in the east central part of the area, near the RSI landfill. This area includes 11 sample locations: SS-22, SS-23, SS-24, SS-25, SS-26, SS-30, SS-42, SS-43, SS-44, SS-45, and SS-59 (see Figures 2-12, 4-20, and 4-21). In this area lead concentrations ranged from 712 mg/kg to 10,800 mg/kg, the average lead concentration was 4,500 mg/kg, and the 95% UCL was 11,700 mg/kg. This compares to a range of 69.1 mg/kg to 956 mg/kg, an arithmetic average of 300 mg/kg, and a 95% UCL of 380 mg/kg among the remaining 35 samples in the Contaminated Soil Area. The area of 11 samples is, therefore, identified as a "hot spot." In order to fully characterize risks, exposures to lead within and outside of the hot spot are evaluated. Exposures are assumed to be concentrated within (or outside) the hot spot, with no reduction in exposure frequency. Within the hot spot area, where the maximum concentration of 10,800 mg/kg is selected as the exposure point concentration, the predicted blood lead level in adults is 17.3 µg/dL, exceeding the identified goal of 4.2 µg/dL. The predicted blood lead level in adults exposed to the remainder of the Contaminated Soil Area is below the goal.

6.5.2.3 Summary of Site Risks. An overall summary of cancer and noncancer risk estimates for the RME trespasser, worker, and resident are presented in Table 6-45. All ILCRs and HIs estimated for the trespasser and site worker scenarios were within acceptable limits, i.e., ILCRs between 1×10^{-4} and 1×10^{-6} and HIs less than 1. However, evaluation of potential lead exposures in two areas of the Site (B&M Locomotive Shop Disposal Area and the Contaminated Soil Area), with particular elevation estimated for the metals hot spot in the Contaminated Soil Area, indicates that exposures could lead to excessive blood lead levels in women of childbearing age. Both ILCRs and HIs for the hypothetical future resident drinking the groundwater from wells on the Site were unacceptable.

The ILCRs exceeded 1×10^{-4} for the RME individual in 12 well groups and for the central tendency individual in two well groups. The HIs exceeded 1, when HQs were added only for chemicals with like target organs or critical effects, in 12 well groups when evaluated for RME exposures. These data indicate that allowing the use of site groundwater for residential consumption in the future will not be possible unless remediation of the groundwater is conducted.

6.5.3 Description of Uncertainties

Estimation of risks to human health that may result from exposure to chemicals in the environment is a complex process that often requires the combined efforts of multiple disciplines. Each assumption, whether regarding the toxicity value to use for a particular chemical or the value of a parameter in an exposure equation, has a degree of variability and uncertainty associated with it. In each step of the risk assessment process, beginning with the data collection and analysis and continuing through the toxicity assessment, exposure assessment, and risk characterization, conservative assumptions are made that are intended to be protective of human health and to ensure that risks are not underestimated. The following section provides a discussion of the key uncertainties that may affect the final estimates of human health risk in this risk assessment. Uncertainties are arranged by topic.

6.5.3.1 Environmental Sampling and Analysis. The process of environmental sampling and analysis results in uncertainties from several sources, including errors inherent in sampling procedures or analytical methods. One area of uncertainty is sampling procedures. Since it is not possible to sample the entire area of interest at a given site, several samples are taken from each medium within each area of the site, and the results are considered to be representative of the chemicals present throughout the area. Analytical methods also involved uncertainties. Due to uncertainty of quantification, individual chemicals were sometimes listed as detected, but with the value qualified as estimated by laboratory qualification or validation procedures. The estimated value was used in the risk assessment. In some cases, analytical errors or sampling errors resulted in the rejection of data, which decreased the amount of data available and increased uncertainty associated with the representativeness of the detected chemical concentrations.

When calculating exposure point concentrations from sampling data, one-half of the reported detection limit was used for nondetected concentrations in the calculation of the mean and the 95% UCL on the mean. Even if one-half of the detection limit was greater than the maximum measured value, one-half the detection limit was still used to calculate the 95% UCL on the mean exposure point concentration. As a result, the mean and 95% UCL of the mean exceeded the maximum detected concentration in a number of instances, and the maximum detected concentration was used for the exposure point concentration in these cases. This use of the maximum detected concentration also has associated uncertainty, since it may underestimate or overestimate the actual exposure point concentration.

Treating the nondetects as "hits" at one-half the detection limit requires making assumptions about the distribution of that data that may result in an overestimate or underestimate of the mean and 95% UCL of the average concentrations. The more nondetects there are, the higher the relative uncertainty of the exposure point concentration. Fortunately, for almost all of the locations evaluated, the majority of the HI and ILCR was contributed by analytes with a high frequency of detections.

Calculations of 95% UCLs were consistently based on an assumption that each COPC in each area of the site had a lognormal distribution. In most cases, the number of samples is too small to demonstrate that concentrations approximated a lognormal distribution. In the area with the most samples, the Contaminated Soil Area, it is clear that concentrations are better described with a lognormal distribution than with a normal distribution. Nevertheless, the actual distribution fits neither distribution precisely. Since the equation for predicting the 95% UCL of the arithmetic mean from a lognormal distribution is sensitive to the shape of the distribution (i.e., the equation is not robust relative to the assumption of lognormality), exposure point concentrations selected for some analytes in some areas may not reasonably reflect arithmetic average concentrations. Some of the predicted 95% UCLs are unreasonably high, while some are actually below the arithmetic mean of the samples.

6.5.3.2 Selection of Chemicals for Evaluation. A comparison of maximum detected chemical concentrations to EPA Region III RBCs was conducted for each medium. Chemicals whose maximum concentrations were below their respective cancer RBCs or 10% of their noncancer RBCs were not carried through the assessment. It is unlikely that this risk-based screening excluded chemicals that would be of concern, based on the conservative exposure assumptions and conservatively derived toxicity criteria that are the basis of the RBCs. Although following this methodology does not provide a quantitative risk estimate for all chemicals, it focuses the assessment on the chemicals accounting for the greatest risks (i.e., chemicals whose maximum concentrations exceeded their respective RBCs), and, although the overall risk estimates are uncertain, it is not expected that actual risks will be significantly greater than estimated risks.

6.5.3.3 Toxicological Data. Uncertainty is associated with the toxicity values and toxicity information available to assess potential adverse effects. For this Site, there is a probability of overestimating health risks or hazards for a number of reasons, which are discussed in the following sections.

One of the major contributors to uncertainty is the accuracy of the toxicity values used. Up until the present, the assumptions used by the EPA in the dose-response extrapolation model for carcinogens were based on a 95% UCL of the maximum likelihood estimate. Other assumptions include the following: 1) the extrapolation of data from high-dose exposures in human and animal studies to the low-dose exposure region of the general population is linear and does not have a threshold; 2) there is an interspecies (i.e., animal to man) correlation, based on body surface area; and 3) there is a conditional probability that cancer incidence demonstrated in animal studies will be similar to the incidence in potentially exposed humans. To the extent that any of these assumptions are incorrect, the extrapolated risks may be over- or underestimates.

As an example of how risk estimates can change, the latest proposed guidelines for carcinogenic risk assessment are different in two major ways (U.S. EPA, 1996f). The first is in the use of a body weight to the three-fourths power conversion, instead of a body weight to the two-thirds conversion as a scaling factor for interspecies extrapolation. This change alone would reduce the SFs based on animal data by a factor of 3 if all else is held constant. In addition, in the new guidance, there are changes in assumptions about the dose-response curve. In the past, all potential carcinogens were assumed to have a linear dose-response curve. The major difference is that new guidance acknowledges that the toxicity of some chemicals may be nonlinear. In the case of chemicals for which there is evidence of a nonlinear mode of action, the allowable dose could be one or two orders of magnitude higher using the new methodology. One chemical for which there is some evidence of a nonlinear dose-response is arsenic (Chen et al., 1992; Tseng, 1977; Tseng et al., 1968). Since arsenic is the main contributor to potential cancer risks of future residents from the ingestion of groundwater in most areas of the site, the interpretation of whether there is a non-toxic threshold for arsenic could affect whether arsenic levels in groundwater are considered allowable. The quantitative estimates of risk presented in this risk assessment assumes no threshold for carcinogenicity from arsenic, which may overestimate risks.

6.5.3.4 Exposure Assessment. The primary areas of uncertainty affecting exposure parameter estimation involve the assumptions regarding exposure pathways, the estimation of exposure point concentrations, and the parameters used to estimate chemical doses. The uncertainties associated with these various sources are discussed below.

The bioavailability of the COPCs from the oral exposure route through the ingestion of soil is uncertain. The animal bioassays on which the RfDs and oral SFs are based do not involve feeding of chemicals in a soil matrix. Oral absorption of chemicals from soil is generally diminished due to the matrix effect of the soil. This is particularly true for the inorganics that may be a component of the mineral structure of the soil and, thus, may not be available for uptake. Therefore the lack of an adjustment for oral absorption from soil is a major uncertainty when calculating risk from the ingestion of soil. Actual risk is likely to be overestimated for this reason.

For dermal exposure pathways, the absence of dermal toxicity criteria necessitated the use of oral toxicity data. To calculate risk estimates for the dermal pathway, absolute oral bioavailability factors that reflect the toxicity study conditions were used to modify the oral toxicity criteria. For the chemicals for which sufficient information is lacking, a default oral absorption factor of 100%

(1.0) was used. The risk estimates for the dermal pathways may be over- or underestimated depending on how closely these values reflect the difference between the oral and dermal routes.

The exposure pathways selected for evaluation were based on potential average and RME case exposures. For example, it was assumed that trespassers would engage in on-site activities at frequent intervals (26 or 52 times a year) under current land-use conditions that would result in exposures to COPCs (i.e., contact with soil, sediment, and surface water). This assumption is conservative, in that it is expected that the activities assumed to occur in this analysis would occur only occasionally, if at all. The assumption that future area residents would regularly ingest groundwater from the site as drinking water was also conservative. Since the Site is designated for industrial uses, and it is not anticipated that groundwater will be used in the future, it is unlikely that residential exposures to groundwater would occur at all.

With respect to determining exposure point concentrations, one assumption was that the concentrations of chemicals in the media evaluated would remain constant over time. Depending on the properties of the chemical and the media in which it was detected, this assumption may overestimate risks, depending on the degree of chemical degradation or transport to other media. Conversely, biodegradation of chemicals in groundwater to more toxic chemicals, such as vinyl chloride from precursors such as TCE, was also not considered.

The parameter values used to describe the extent, frequency, and duration of exposure are associated with some uncertainty. Actual risks for some individuals within an exposed population may vary from those predicted depending upon their actual intake rates (e.g., soil ingestion rates) or body weights. The exposure assumptions were selected to produce an upper-bound estimate of exposure in accordance with EPA guidelines regarding evaluation of potential exposures at Superfund sites (e.g., exposures were assumed to occur for 5 to 10 years for trespassers and for 15 to 25 years for workers). Therefore, exposures and estimated potential risks for the majority of the evaluated receptors are likely to be overestimated.

6.5.3.5 Risk Characterization. Cancer risks and HIs for each receptor were not summed across different media. For example, the risks to the trespasser from soil ingestion and dermal contact were not summed with those from exposure to sediment and surface water. In addition, risks from a given medium were not summed across areas of concern. That is, for the trespasser, risks from ingestion of and dermal contact with soil were assumed to occur within a given area of concern, like the B&M Railroad Landfill. This assumption is uncertain since a given trespasser may spend half his time in one area of concern and half in another. Risks to such an individual would be intermediate between the risks to individuals exposed solely to each area of concern.

Residential exposure to groundwater was assessed quantitatively only for the direct ingestion pathway. Risks from drinking water exposure to groundwater exceeded allowable levels in the RME evaluation all 15 well groups on the Site. Other exposures resulting from the use of groundwater by area residents likely include dermal contact (e.g., while bathing) and inhalation (e.g., while showering). Risks from dermal contact with some chemicals present in groundwater would add to the risks calculated from the ingestion of groundwater. In addition, risks from the inhalation of VOCs during showering would also add to total risks from residential exposure. Volatile organic compounds present in the groundwater included such chemicals as benzene, 1,1-DCA, 1,2-DCA, TCE, and chloroform. These VOCs would be released into household air during showering, cooking, and clothes and dish washing to present an increased risk to individuals exposed through inhalation. The magnitude of this risk would depend on the frequency and duration of exposures for these individuals. Risk from inhalation of volatiles does not typically increase total risk to more than double the risk calculated for ingestion of drinking water alone. The assumption that the RME individual ingests 2 liters of water per day may be sufficient to account for much of this uncertainty.

6.5.3.6 Overall Uncertainty. This risk assessment contains many layers of conservative assumptions. For example, in the RME case, the value selected for each parameter in each equation used to calculate risks to the RME individual is a maximum or upper-bound assumption. Therefore, the estimated risk is likely to be greater than the 95% UCL of all potential risks. If the risk assessment was able to capture the uncertainty and variability associated with each parameter, it is likely that the actual potential risk to the RME individual would be less than the risks estimated in this assessment.

6.5.4 Risk Characterization Summary

Potential human health risks were estimated for exposures to surface soil at the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Area, the Old B&M Oil/Sludge Recycling Area and the Contaminated Soil Area. Risks were estimated for a trespasser receptor and for a worker receptor. Risks to these receptors were within or below EPA's target risk ranges for both carcinogenic and non-carcinogenic risks and for both central tendency and RME evaluations. Exposure to lead in the B&M Locomotive Shop Disposal Area and the Contaminated Soil Area, particularly the metals hot spot, could lead to excessive blood lead levels in women of childbearing age.

Potential human health risks were estimated for exposures to sediment and surface water for a trespasser receptor. Sediment and surface samples were both grouped into three areas: the West Middlesex Canal Area, the Central Wetlands Area, and the East Middlesex Canal and Wetlands Area. The trespasser receptor was expected to be the most highly exposed receptor. Risks were within or below EPA's target risk ranges for both carcinogenic and non-carcinogenic risks, for both sediment and surface water and for both central tendency and RME evaluations for all three areas.

Potential human health risks were estimated for future exposures to groundwater as a source of drinking water in each of three flow zones at the following five areas of concern: the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Area, the Old B&M Oil/Sludge Recycling Area, and the Asbestos Lagoons. Considering a RME receptor, either carcinogenic risks or noncarcinogenic risks or both would exceed EPA's target risk range in nearly all flow zones at each area of concern. Arsenic and manganese were determined to be the principal sources of risk. For a central tendency evaluation, cancer risks were found to be excessive only in the shallow overburden (1.5×10^{-4}) and deep overburden (2.6×10^{-4}) flow zones of the RSI Landfill. Target organ-specific hazard indices exceeded a target of 1 for the central tendency evaluation in shallow overburden at the B&M Railroad Landfill, shallow and deep overburden at the RSI Landfill, shallow overburden at the B&M Locomotive Shop Disposal Area, and in shallow and deep overburden and bedrock at the Asbestos Lagoons.

In conclusion, there would appear to be a risk in consuming groundwater from the Site due mostly to the presence of inorganic materials in groundwater, if site groundwater were used as a drinking water supply in the future. Soil at the B&M Locomotive Shop Disposal Area and from a hot spot of lead contamination in the Contaminated Soil Area could present health risks under current conditions. Otherwise, there do not appear to be human health risks associated with contact with other site media. Uncertainty associated with these conclusions is discussed in section 6.5.3. The potential for groundwater contaminants to migrate to downgradient receptors was not modeled in this risk assessment.

SECTION 7.0
ECOLOGICAL RISK ASSESSMENT

The purpose of the ecological risk assessment (ERA) is to evaluate the probability and magnitude of adverse effects to ecological receptors associated with actual or potential exposure to chemicals identified within the 3rd operable unit. The approach used to assess ecological risks is based on the general conceptual framework for ERA at a Superfund site outlined by the EPA (U.S. EPA, 1992f), and is consistent with other ecological guidance published by U.S. EPA (1989a and h; 1991a, 1992a and c; 1994a; 1996a and b). The ERA also reflects comments and guidance received from EPA Region I regarding the Iron Horse Park Superfund Site and incorporates data from the scientific literature used in conjunction with professional judgement.

This analysis represents an evaluation of the no-action alternative (i.e., it examines the potential ecological /impacts associated with the Site if no further remedial action were to occur). The areas investigated in this ERA included: Asbestos Lagoons, Old B&M Oil/Sludge Recycling Area, Contaminated Soil Area, B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, RSI Landfill, and site-wide surface water and sediment. The other two operable units at the Site, the B&M Wastewater Lagoons (operable unit 1) and the Shaffer Landfill (operable unit 2), are not addressed in this assessment. The remainder of this assessment is divided into six principal sections:

- **Section 7.1—Problem Formulation** is the planning and scoping phase that specifies the objectives and breadth of the ERA. The history, physical setting, surrounding land use, and habitats/ecological resources known or likely to occur on the site are first described. The sample data are then summarized by presenting the frequency of detection and the range of detected concentrations in on-site and background samples from each of the media (surface soil, sediment, and surface water). The chemicals of potential concern (COPCs) are then selected from these data. Based on significant ecosystem characteristics of the Site and characteristics of the COPCs, the potential exposure pathways and ecological receptors are selected. Finally, from this information, the specific environmental properties at risk that are used to evaluate the state of the ecological system (assessment endpoints) and the aspects of the ecological system that are measured to characterize the assessment endpoints (measurements endpoints) are determined.

- **Section 7.2—Characterization of Exposure** identifies the concentrations and/or doses of the COPCs to which ecological resources selected for evaluation in the ERA could be exposed. Exposure for selected receptor populations or communities is quantified by combining information on the spatial and temporal distribution of chemicals within the environment (i.e., surface soil, sediment, and surface water) with that of the spatial and temporal distribution of the ecological receptors being evaluated.

- **Section 7.3—Characterization of Ecological Effects** describes the toxicity of the COPCs being evaluated. Specifically, this section defines the relationship between chemical concentration (i.e., stressor) and a given ecological effect (i.e., assessment endpoint). In addition, benthic macroinvertebrate survey results from the site-specific biological investigations conducted in various on-site wetlands are discussed.

- **Section 7.4—Risk Characterization** presents quantitative and/or qualitative estimates of risk for each of the selected receptors by combining the exposure and ecological effects information. The assessments of risk are limited primarily to the population level because data on community and ecosystem level responses to environmental pollutants generally are lacking. However, where possible, the implications of population level impacts on the community or ecosystem are qualitatively discussed. A qualitative uncertainty analysis is also presented in this section that identifies and discusses the principal uncertainties associated with the ERA.

- **Section 7.5—Summary and Conclusions**. The findings of the ERA are reviewed.

7.1 PROBLEM FORMULATION

The problem formulation section of the ERA evaluates available information about the site history and past land use activities, the ecological resources and the COPCs associated with the Site, and the pathways by which ecological receptors could be exposed to COPCs. The section concludes with the identification of the ecological resources and the endpoints selected for evaluation in the ERA.

The problem formulation consists of the following sub-sections. Section 7.1.1 provides a general overview of the Site and includes a description of the history, past and present land use patterns, contaminants known to be associated with on-site activities, and the habitats/ecological resources known or likely to occur on the Site. Section 7.1.2 identifies the data groupings selected for each medium and the COPCs selected for evaluation. Section 7.1.3 identifies the exposure pathways and ecological receptor species selected for evaluation in Section 7.1.4. Finally, Section 7.1.5 identifies the assessment endpoints identified for evaluation in the ERA, and the methods and/or data used for the evaluation of these endpoints.

7.1.1 General Site Description and Characterization of Past On-site Activities

The Site occupies approximately 553 acres of land in North Billerica, Massachusetts (Middlesex County), near the Tewksbury town line, approximately 20 miles northwest of Boston (Figure 1-2). The Site is an active industrial complex and railyard with a long history of activities (since 1911) which have resulted in contamination of soils, groundwater, surface water, sediment, and air at the Site. This large Site includes numerous manufacturing operations, open storage areas, landfills, and lagoons, some of which began operating in the early 1900's. Contaminants known to have been disposed of at the Site include asbestos, PCBs, solvents, waste oils, and other chemicals (CDM, 1987).

Changes in physical characteristics of the Site have occurred during the years of operation, due to the creation and eventual expansion of several landfills, open storage areas, and lagoons. Current landowners and operating companies include General Latex, B&M Corporation, Penn Culvert, Spincraft, Wood Fabricators, BNZ Materials, and George McQueston Lumber. See section 1.0 for further details concerning the site history and current activities at the Site.

The Site has been divided into three operable units: the B&M Wastewater Lagoons (operable unit 1), the Shaffer Landfill (operable unit 2), and the remaining 10 areas of concern defined as operable unit 3 (the B&M Railroad Landfill, the B&M Locomotive Shop Disposal Areas, the RSI Landfill, the Old B&M Oil/Sludge Recycling Area, the Contaminated Soil Area, the Asbestos Landfill, the Asbestos Lagoons, PCB Contamination, Groundwater Contamination, and Site-Wide Surface Water and Sediment Contamination). The ERA will focus on 3rd operable unit, which is shown in Figure 1-2. It is important to note that the ERA will not evaluate groundwater contamination, although any chemicals discharging to surface water from groundwater would have been detected in the surface water/sediment sampling data and thus will be evaluated.

Along with the industrial sections of the Site, there are a number of wetland complexes as well as forested areas. The Middlesex Canal flows through the Site to the east where it joins Content Brook at the southeastern edge of the Shaffer Landfill, and then flows to the Shawsheen River and ultimately to the Merrimack River to the north. The topographic high lies just to the south of the Site; the topographic low lies to the northeast of the Site at Richardson Pond. The Iron Horse Park Site is bounded on the north by the B&M railroad tracks, on the west side by High Street and an auto salvage yard, on the east side by Gray Street and on the south side by a wetland, Pond Street, and the Middlesex Canal, which is also an abundant wetland area. Residential properties lie to the north and south of the Shaffer Landfill.

7.1.1.1 Aquatic and Terrestrial Habitats. The Site is composed of industrial areas, wetland, and upland habitats (Figure 7-1). Approximately 20% of the 553 acre site is forested, while 17% is wetland habitat. In addition, several large wetland complexes border the Site (Richardson Pond [Wetland 3] and Fox Brook [Wetland 8] wetlands; see Figure 7-2), which increases the total acreage of wetlands at the Site to 266 acres. The Site can be divided into two sections: areas west of Pond Street and areas east of Pond Street. The western portion of the Site contains the current industrial sections which are primarily unvegetated. These areas include railyards, buildings, roads, and parking areas. In addition, three landfills occupy the western portion of the Site and include: the RSI Landfill, B&M Railroad Landfill, and the Johns-Manville Asbestos Landfill. The B&M Railroad Landfill contains a mixture of early successional field habitat with areas of bare soil and pockets of saplings and shrubs. The other two landfills are open field habitats with 100% herbaceous cover dominated by early successional grasses and herbaceous species. The remainder of the western portion of the Site is covered by forest and wetland habitats. The upland habitats are dominated by oak/hickory/maple forest with mixed areas of hardwood/softwood forest (oak/hickory/white pine) in patches mainly near the Pond Street boundary. The largest tract of undisturbed forest in the Site occurs west of Pond Street and south of the Johns-Manville Asbestos Landfill. This tract is 50 acres in area and is dominated by a dense canopy of oak/pine with a very open understory. Lastly, there are some scrub and shrub habitats in the western portion of the Site (M&E, 1995).

The eastern portion of the Site (including Shaffer Landfill, which is not part of the 3rd operable unit) is composed of unvegetated landfill (60%) and wetland (20%) with the remainder consisting of upland and scrub/shrub habitat that border the landfill and wetland areas. Three wetland complexes border the eastern portion of the Site: the Content Brook wetland system (Wetland 9), Richardson Pond wetland system (Wetland 3), and the forested wetland south of Shaffer Landfill and Middlesex Canal (Wetlands 6 & 8) (Figure 7-2).

7.1.1.2 Wetlands. A qualitative function and values assessment was completed for the 11 wetlands that occur within or adjacent to the Site during field surveys in 1993 and 1994 (M&E, 1995: Figure 7-1). Please note that most of the wetlands represented in Figure 7-2 are mosaics of habitat types and only the predominant habitat was used to classify each wetland. The functions evaluated included: groundwater recharge/discharge, floodflow alteration, sediment/shoreline stabilization, sediment/toxicant retention, nutrient removal/retention, production export, fish and shellfish habitat, wildlife habitat, endangered species habitat, visual quality/aesthetics, educational scientific value, recreation, and uniqueness/heritage. Below is a brief synopsis of the findings presented in M&E (1995), focusing on a physical description of each wetland, the sediment/toxicant retention capacities, capability of supporting a warm water fishery, and suitability of the wetland as wildlife habitat. Protected species are not known to inhabit any of these wetland areas (M&E, 1995).

Eleven wetland areas are described. Many of the wetland areas on the Site were defined and named in the Wetland Characterization Report (Weston, 1989). To facilitate discussion in the ERA, each wetland area was given a number. For example, the Barge Turnout Wetland Area is designated on Figure 7-2 as Wetland 1.

Wetland 1—Barge Turnout Area. This 13-acre wetland (Figure 7-2) is located in the northwest portion of the Site, bordered by the Middlesex Canal to the south and the B&M Railroad to the north. At the center of the wetland, the Middlesex Canal is contiguous with the open water of the former Barge Turnout pond. Dense emergent and scrub/shrub habitat surround the open water area. In addition, forest habitat is also present. A small tributary that drains a small wetland complex to the north of the B&M Railroad Landfill flows into this wetland. Flow from the Barge Turnout Wetland flows into Middlesex Canal, which discharges into the B&M wetland to the east.

This wetland is suitable for sediment/toxicant retention due to high vegetation density, depositional environment, slow water flow, and areas of open water interspersed with vegetation. In addition, the watershed of this wetland contains potential contamination sources. There is potential for limited fish habitat as warm water fish have been observed within the drainage and open water habitat exists. Although there is not an undisturbed upland buffer present around the wetland, this wetland is considered to be valuable wildlife habitat due to the size of the wetland, diversity of vegetation, and proximity of the wetland to other large wetland complexes.

Wetland 2—B&M Wetland. This is the largest wetland complex (40 acres) within the 3rd Operable Unit portion of the Site (Figure 7-2) and is located in the north-central part of the Site. Middlesex Canal flows into the B&M wetland at the northwest corner. This wetland is bisected through the center by a separate segment of the canal. The eastern side of the wetland is bordered by mixed forest (oak/pine) for approximately 200 feet. The remainder of the wetland is bordered by landfill. Open water areas occur in the northern section of the wetland where large areas of emergent growth are bordered by scrub/shrub habitat. The southern end of the pond is predominantly palustrine emergent growth.

This wetland is suitable for sediment/toxicant retention due to the high vegetation density, slow water flow and areas of open water, interspersed with vegetation. This wetland also receives drainage from several potential contaminant sources. There is potential for limited fish habitat as warm water fish have been observed within the drainage and open water habitat exists. Although there is not an undisturbed upland buffer present around the wetland, this wetland is a valuable wildlife habitat due to the size of the wetland, diversity of vegetation, and proximity of the wetland to other large wetland complexes (Richardson Pond).

Wetland 3—Richardson Pond. This large (approximately 100 acres) wetland complex (Figure 7-2) is located north of the Shaffer Landfill and receives flow from upstream wetlands at the northwest corner of the pond. Richardson Pond is separated from the rest of the Site by the B&M railroad embankment. The major outflow of the pond is Content Brook which flows into the Content Brook wetlands (Wetland 9).

This wetland is suitable for sediment/toxicant retention due to diffuse water flow through the wetland and high vegetation density. Potential leachate or surface water contaminant discharge in the form of orange-colored deposits has been observed at the southwest corner of the wetland. This could be the result of groundwater discharge or surface water drainage from a culvert under the railway from the B&M wetlands. Fishery habitat is likely to occur in this wetland due to the large size and connection with Content Brook. In addition, it is permanently inundated and open water occurs. However, the depth of water is generally less than 3 feet so an extensive warm water fishery is not expected. The large size of the wetland in conjunction with the vegetative structure and diversity, provide good quality wildlife habitat. The habitat quality is also enhanced by the proximity of the Long Pond and Content Brook wetland systems. The occurrence of a variety of wildlife and waterfowl has been noted in the wetland.

Wetland 4—Pock Forested Wetland. The headwaters of the unnamed brook, behind the Purity Supreme complex, comprise this small forested wetland (Figure 7-2). This brook drains the central portion of the Site into the B&M Wetland (Wetland #2). The red maple-dominated palustrine forested wetland had been increasingly inundated due to beaver activity observed in 1993 and 1994 field studies downstream of the wetland on the unnamed brook. Bullfrogs were observed using ponded water (6 to 8 inches in depth) in July 1993.

This wetland is suitable for sediment/toxicant retention due to diffuse water flow through the wetland and high vegetation density and a potential source (B&M Locomotive Shop Disposal Area B) within the watershed. The wetland habitat is relatively unsuitable for supporting significant fish populations given the small size and shallow depth of the open water. Beaver, amphibians, and avian species have been observed to use the wetlands despite the small size of the wetland and proximity to residential, commercial, and industrial land uses.

Wetland 5—Fire Pond. Small man-made basins and channels associated with the unnamed brook comprise this wetland (Figure 7-2). A small area of emergent and scrub/shrub vegetation occurs immediately downstream of the Fire Pond. Open water occurs in the upstream pond, while the wetland to the north is covered with emergent marsh and aquatic bed vegetation.

This wetland is suitable for sediment/toxicant retention due to the depositional environment of the Fire Pond and high vegetation density in the adjacent wetland. In addition, the pond is located downstream of potential contaminant sources. The wetland habitat is relatively unsuitable for supporting a diverse fish community given the small, shallow nature of the wetland. However, during field work in July 1993 at the Fire Pond, a large number of small bluegills were observed. Raccoon, beaver, painted turtles, and a number of avian species have been observed in this wetland complex despite the relatively small size of the wetland and proximity to industrial activities.

Wetland 6—Middlesex Canal Wetland Pockets. Southeast of the Shaffer Landfill there are areas of predominantly forested wetland (Figure 7-2). The Middlesex Canal residential developments constitute the northern and southern boundaries, respectively, of this wetland.

Although Wetland 6 is capable of some sediment/toxicant retention, there are no potential sources of site-related sediment or toxicants, as the watershed of this wetland is largely residential. This wetland lacks adequate standing water to support significant fisheries habitat. Although the majority of the vegetation in this wetland is forested red maple, the relatively small size and proximity to the Industrial Park limit the habitat value for some species.

Wetland 7—Shaffer Landfill Wetlands. Approximately 8.3 acres of predominantly scrub/shrub and forested wetland (Figure 7-2) occur between the two lobes of the Shaffer Landfill. The landfill borders over 50% of the wetland edge. No permanent inlets or outlets exist for this wetland. In addition, Shaffer Landfill encompasses the entire watershed of this wetland.

This wetland is suitable for sediment/toxicant retention given the high vegetation density and lack of a defined outlet. In addition, a potential source exists as sediment and toxicant loads are probably received from the Shaffer Landfill. This wetland is relatively unsuitable for supporting significant fisheries habitat due to the lack of sufficient standing water. Given the lack of suitable open water habitat and the proximity of the landfill, wildlife habitat value is limited. However, the value is enhanced by the habitat structure of the wetland, which includes vegetative class interspersion, presence of snags, and proximity of nearby wetlands with high wildlife food value.

Wetland 8—Fox Brook Wetland. The large red maple-forested Fox Brook Wetland (Figure 7-2) is located south of Shaffer Landfill. Both Middlesex Canal and Fox Brook border this 53 acre wetland. The watershed of this wetland is largely residential and no potential sources of significant sediment or toxicant loads are present. During normal flow conditions, sediment retention would be limited in this wetland. Since the open water habitat in the wetland is limited to Fox Brook, this wetland is considered to have limited potential as fisheries habitat. The wildlife habitat is considered a principal valuable function of this wetland given the presence of vegetation with high wildlife value (particularly shrubs), large size, and proximity to other habitats, including the East Middlesex Canal and the Content Brook Wetlands (Wetland 9).

Wetland 9—Content Brook Wetlands. This 18-acre wetland complex (Figure 7-2) is located at the southeast end of the Shaffer Landfill, bordering Content Brook, which flows to the southeast. Middlesex Canal is the southern boundary for this wetland. The surface water inlet to this wetland provides perennial drainage from Richardson Pond. There are 1.2 acres of emergent wetland, predominantly common reed, on the western portion of the wetland. There is no observable surface water connection to the remainder of the wetland complex bordering Content Brook. Surface water flow in the brook is through a complex of forested, scrub/shrub and emergent wetlands with areas of open water.

Shaffer Landfill is located in part of the Content Brook watershed and represents a potential source of sediments and toxicants. In fact, strong petroleum odor was noted in sediments in Content Brook during field investigations in October 1993. Suitable conditions for sediment and toxicant deposition occur in this wetland due to high vegetation density, slow water flow, and areas of open water interspersed with vegetation. Content Brook is likely to be habitat for a limited warm water fishery as it is a perennial stream and a tributary to the Shawsheen River.

The forested, emergent, scrub/shrub and open water habitats could serve as habitat for a variety of avian and mammalian species. Although there is not an undisturbed upland buffer, the diversity of vegetation and proximity of the wetland to other large wetland complexes contributes to a valuable wildlife habitat. Gray squirrel, eastern chipmunk, red fox, beaver, and a variety of bird species were observed.

Wetland 10—Burnham Road Wetland. The Burnham Road Wetland (Figure 7-2) is located upstream of the Barge Turnout, north of the B&M railroad tracks and outside the Site boundaries. Reference samples of surface water, sediment, and aquatic invertebrates were collected within the wetland in 1993. The main body of the wetland receives flow from an intermittent stream to the north. The top of the watershed is nearby and is partly forested and partly residential. Emergent vegetation dominates the eastern portion of the wetland and scrub/shrub habitat dominates the western portion. Burnham Road separates the southern portion of the wetland from the northern portion. Outlet from this wetland discharges through a stream which ultimately flows into the Barge Turnout Wetland (Wetland 2).

Although the forested habitat may promote sediment retention, there are no potential sources of significant sediment or toxicant loads, as the watershed is largely residential. Although a small pickerel was caught during field activities in October 1993, the small unnamed stream is the only open water area. Thus, a limited warm water fishery is supported by the stream. The emergent and scrub/shrub wetland likely serves as habitat for a variety of avian and mammalian species. This wetland is considered to be valuable wildlife habitat given that it is part of a larger wetland complex (Wetland 2) and a short distance to open water habitats (B&M Pond, Richardson Pond).

Wetland 11—High Street Wetland. This wetland (Figure 7-2) is located west of High Street and south of the Middlesex Canal, outside of the site boundaries. Reference samples of surface water, sediment, and aquatic invertebrates were collected within the wetland in 1993. This wetland, as well as being bordered by High Street, is also bordered to the west and south by residential lots.

Middlesex Canal is located 100 feet to the north but there is no surface water connection between these two water bodies. Palustrine emergent wetland is the main vegetation type. On the northern end of the wetland is a small pond surrounded by emergent vegetation that is fed by an intermittent stream. There is no permanent outlet associated with this wetland.

Although the dense emergent and scrub/shrub vegetation of the wetland would serve to retain sediments, there are no potential sources of significant sediment or toxicant loads, as the watershed is largely residential. Small bluegills were observed in a very small, shallow pond in 1993. However, this pond is the only open water habitat within the wetland. As a result, this wetland does not appear to support a significant warm water fishery. The emergent and scrub/shrub wetland habitat could serve as habitat for a variety of avian and mammalian species. However, given that there is little forested border, and High Street forms one of the borders, habitat utilization by wildlife is expected to be limited.

7.1.1.3 Terrestrial and Aquatic Receptors. Although portions of the Site are industrial in nature and provide little, if any, suitable habitat for terrestrial and aquatic receptors, the diversity of vegetation types present in the non-industrial portions at and near the Site provide potential habitat for a wide variety of wildlife species. Unless otherwise noted, the wildlife information presented in this section was based upon wildlife surveys conducted on May 10 and 11, and July 15, 1993 as part of the reconnaissance field surveys by M&E (1995).

Birds. A total of 39 bird species were identified during the 1993 reconnaissance surveys, 21 of which were observed on both the eastern and western portions of the Site. Furthermore, 19 of these species were observed by Weston (1989) in a one day survey of the entire Site (within the site boundaries and including Richardson Pond, Content Brook, and Fox Brook wetlands) on October 1987. Given the low intensity of the reconnaissance-level survey and seasonal limitations in both surveys, the number of avian species occurring within the Site is probably more than represented in Table 7-1.

Although few water birds and raptors were observed, many passerines were noted. The waterfowl observed included Canada geese, mallard and wood duck. In addition, belted kingfisher, great blue heron, and green-backed heron were observed. Red-tailed hawk and American kestrel were the only two raptor species noted by M&E (1995). However, Coopers hawk, northern harrier, and merlin were observed by Weston (1989). During both surveys, three species of woodpecker (northern flicker, downy woodpecker, and hairy woodpecker) were observed. The most common passerines noted were those species, such as American goldfinch and American robin, that use field, shrub, or edge habitats. Forest species, such as black-capped chickadee, blue jay, and wood thrush, were also observed. Tree swallow, red-winged blackbird, and common yellow-throat, common inhabitants of streams and marshes, were also observed.

Mammals. The May 1993 reconnaissance noted 11 species of mammals through direct observation or by sign. No one species was observed in both portions of the Site and the majority were noted in the eastern portion of the Site. This is not unusual given the industrial nature of the western portion of the Site. The Weston (1989) surveys indicated an additional six species, along with four (eastern cottontail, raccoon, shrew spp., and woodchuck) of the 11 species observed during the May 1993 reconnaissance. Beaver, eastern chipmunk, opossum, red fox, striped skunk, white-tailed deer, and woodchuck were the remaining mammalian species reported in the survey. Two species of bats, little brown bat (*Myotis lucifugus*) and the big brown bat (*Eptesicus fuscus*), although not noted during the survey, might use the open field habitats to forage for insects (DeGraaf and Rudis, 1983). Differences in survey results can be attributed to the change in seasons and the different areas surveyed, as well as the time of day of the surveys. In addition, tracks and scat were obscured over a large portion the Site due to dense vegetation. Thus, the results of the mammal surveys also probably underestimate the number of different mammalian species at the Site (Table 7-1).

Reptiles and Amphibians. Three species of frogs (bullfrog, green frog, and northern leopard frog) were noted in the reconnaissance survey (Table 7-1). Given the wetland habitat present within the Site, other frog species such as spring peeper (*Pseudacris crucifer*), wood frog (*Rana sylvatica*) and gray tree frog (*Hyla versicolor* and *H. chrysoscelis*) likely occur (DeGraaf and Rudis, 1983). In addition, newts and salamanders, although not observed during surveys, also are likely to occur given the available habitat. Species potentially occurring include: northern dusky salamander (*Desmognathus fuscus*), spotted salamander (*Ambystoma maculatum*), northern two-lined salamander (*Eurycea bislineata*), redback salamander (*Plethodon cinereus*), and red-spotted newt (*Notophthalmus viridescens*) (DeGraaf and Rudis, 1983). Both portions of the Site had common snapping turtles and eastern painted turtles. Given the wetland habitats, other turtle species would also be expected to occur. No snakes were observed during the surveys although many are suspected of inhabiting the Site. These could include: eastern garter snake (*Thamnophis s. sirtalis*), northern brown snake (*Storeria dekayi dekayi*), smooth green snake (*Opheodrys vernalis*), northern ringneck snake (*Diadophis punctatus edwardsii*), eastern ribbon snake (*Thamnophis sauritus sauritus*), and eastern milk snake (*Lampropeltis triangulum triangulum*) (DeGraff and Rudis, 1983).

Fish. Only two species of fish, bluegill and chain pickerel, were observed during benthic reconnaissance activities. However, formal fish surveys were not conducted. The presence of other fish species in the wetlands of the Site is quite probable.

Benthic Macroinvertebrates. The benthic macroinvertebrates observed during the benthic reconnaissance are discussed in section 7.3.

7.1.1.4 Endangered/Threatened Species of Plants and Animals. As part of the ERA, the U.S. Fish and Wildlife Service (USFWS) and the State of Massachusetts Natural Heritage and Endangered Species Program were contacted (M&E, 1995) for information on federally and state-listed threatened or endangered species that may be present at or in the vicinity of the Site. The USWF indicated that, with the exception of occasional transient endangered peregrine falcon (*Falco peregrinus anatum*) or transient threatened bald eagles (*Haliaeetus leucocephalus*), no federally listed or proposed threatened or endangered species were known to occur in the project area. The State Heritage Program also concluded that there are no known rare plants or animals or protected natural communities in the vicinity of the project area. Thus, field reconnaissance, literature review, and contacts with federal, state, and local agencies indicate that no state- or federally listed threatened or endangered species were identified within the Site (M&E, 1995).

7.1.2 Data Summary and Selection of Chemicals of Potential Concern

This section of the ERA discusses the methodology used to summarize the data for the ERA (section 7.1.2.1), the data groupings (section 7.1.2.2), and the methodology used to select COPCs for detailed evaluation in the ERA (section 7.1.2.3). The summarization of data and selection of ecological COPCs are then presented for each medium (surface soil, sediment, and surface water) in section 7.1.2.4.

7.1.2.1 Methodology for Data Summary. The first step of the ERA process was to summarize the analytical data collected during this RI. Detailed discussions of sampling approaches and quality assurance protocols are presented in section 2.0 and analytical results are presented in section 4.0. The following steps, which are in accordance with *Risk Assessment Guidance for Superfund (RAGS)* (U.S. EPA, 1989g) and *Supplemental Guidance to RAGS* (U.S. EPA, 1989i), were used to summarize the analytical data for the ERA.

The analytical data were summarized by environmental medium (i.e., surface soil, sediment, and surface water) and were grouped into source/receptor areas in section 7.1.2.3. A complete description of the sample groupings is provided by environmental medium in section 7.1.2.2. The data were qualified by the analytical laboratory and validated according to EPA Region I guidelines. Qualifying and validating the analytical data included a comparison of the site data to corresponding blank (laboratory, field, equipment, and trip) concentration data. Data that were considered estimated values (e.g., J qualified) were used in the ERA without modification. Rejected data (e.g., R qualified) were not used in the ERA. Analytical data from duplicate samples were averaged together and treated as one result as described in Appendix I.

Arithmetic mean chemical concentrations were calculated by averaging the detected concentrations with one-half the detection limit of the nondetects. One-half the detection limit is typically used in assessments (U.S. EPA, 1989g) when averaging nondetected concentrations because the actual value can be between zero and a value just below the detection limit. This procedure was used even when the nondetect value was two or more times higher than the maximum detected concentration for an analyte in that medium. The uncertainties associated with this methodology are discussed in section 7.4.4.

Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples analyzed, and was determined after the exclusion of rejected (R qualified) data. For surface water samples, the frequency of detection reflects multiple rounds of data collected at a single sample location; surface water samples were collected during two separate sampling rounds, therefore, two sets of analytical results were available for sample locations from these media. To determine the frequency of detection for surface water samples, the analytical results from both sampling events were considered as separate values to evaluate high flow and low flow conditions separately. To determine the frequency for each sediment sampling location, the analytical results from both sampling rounds were averaged together.

7.1.2.2 Data Groupings. As summary data are presented in section 7.1.2.3 by medium and by sample grouping, the specific sampling locations within each grouping for each medium are presented below. Sample groupings were agreed upon by EPA Region I and the M&E team, based on logical habitat units and hydrological connections. Figures 1-2 and 7-1 indicate sampling locations for surface soil, and surface water and sediment, respectively.

Surface Soil Sample Groupings. The surface soil sample groupings are consistent with the areas delineated in the RI sampling plan. In addition, the data are representative of the 0 to 1 feet sampling interval.

- Background (BG) = SS-11 through SS-13

- B&M Locomotive Shop Disposal Areas (A and B) (LSA/LSB) = SS-01 through SS-04

- Old B&M Oil/Sludge Recycling Area (OS) = SS-78 through SS-83

- B&M Railroad Landfill (RL) = SS-61 through SS-74

- RSI Landfill (RS) = SS-05 through SS-10

After consultation with EPA Region I, it was concluded that the Old B&M Oil/Sludge Recycling Area and the Contaminated Soil Area are unlikely to provide suitable habitat for terrestrial receptors (e.g., earthworms and shrews) due primarily to the physical changes to the habitats from industrial activities. As a result, these areas were not evaluated quantitatively in the ERA. The surface soil data were nevertheless presented for these groupings for purposes of comparison.

Surface Water and Sediment Sample Groupings. Given the numerous water bodies present on the Site, a generalized approach based primarily on hydrological connections, drainage areas, and habitat complexes was used to determine the surface water/sediment groupings. Surface water and sediment samples that were grouped into Groups 1 through 5 are discussed below. The background samples that applied to all groupings were SW/SD-319 and SW/SD-321.

Group 1 (West Middlesex Canal Group). Group 1 includes the East Middlesex Canal samples in and adjacent to the Barge Turnout Wetlands and a sample taken north of the Spincraft drainage channel (SW/SD-109) flowing into Middlesex Canal. The four samples from the asbestos lagoons (SD-323 to SD-326) were included in this grouping for sediment samples only.

- West Middlesex Canal/North of Spin Craft - SD/SW-026, SW/SD-028, SW/SD-029, SW/SD-109, SW/SD-307, SW/SD-308

- Asbestos Lagoons - SD-323, SD-324, SD-325, SD-326

Group 2 (Wetland 2 Group). Group 2 includes the unnamed brook and the associated wetlands in the center of the Site, upstream of the RSI Landfill, as well as samples from the large wetland complex north and south of the Middlesex Canal, including the B&M Pond.

This grouping includes samples from both Middlesex Canal, west of Pond Street, and the wetlands and drainage channels contributing to the wetland complex surrounding the B&M Railroad Landfill. Canal and wetland sample locations were grouped together because these areas are contiguous during periods of high water and represent a logical ecological habitat unit for assessing exposures to aquatic organisms. Furthermore, the present grouping represents sampling locations associated with areas that may receive contaminants from the center of the Site (e.g., B&M Railroad Landfill, RSI Landfill, and B&M Locomotive and Shop Disposal Areas A and B).

- Unnamed Brook/B&M Locomotive Shops/Sand&Salt Pile - SW/SD-010, SW/SD-013, SW/SD-118, SW/SD-317, and SW/SD-322

- B&M Pond/Drainage Ditch/RSI Wetland Area and Canal - SD/SW-016, SW/SD-017, SW/SD-107, SW/SD-108, SW/SD-301, SW/SD-302, SW/SD-303, SW/SD-304, SW/SD-305, SW/SD-306

Group 3 (East Middlesex Canal Group). Group 3 includes samples from Middlesex Canal, east of Pond Street. Sampling location SW/SD-113, which is in a wetland area adjacent to the Richardson Pond outlet, has been included with the Richardson Pond Group and not the Content Brook Wetland Group because this area is upgradient of the Content Brook Wetlands.

- East Middlesex Canal - SW/SD-019, SW/SD-020, SW/SD-103, SW/SD-104, SW/SD-105, SW/SD-106, SW/SD-116, and SD-018

Group 4 (Richardson Pond Group). Group 4 includes samples collected in open water and wetland habitats throughout the Richardson Pond wetland complex.

- Richardson Pond - SW/SD-022, SW/SD-111, SW/SD-113, SW/SD-309, SW/SD-314, SW/SD-315, SW/SD-316, and SW/SD-320

Group 5 (Content Brook Wetland Group). Group 5 includes all sample locations in aquatic habitats associated with Content Brook, west of Gray Street, with one sample collected off-site, east of Gray Street.

- Off-site downgradient Content Brook - SW/SD-101, SW/SD-102

- On-site Content Brook - SW/SD-117

- Content Brook Wetland - SW/SD-020, SW/SD-030, SW/SD-310, SW/SD-313

Sample locations SW/SD-311 and SW/SD-312, in wetland #7 at the center of Shaffer Landfill, will not be part of the analysis as these areas have already been capped and restoration is underway.

7.1.2.3 Methodology for Selecting Chemicals of Potential Concern. A review of the analytical data collected for surface soil, surface water, and sediment at the Site indicates that many chemicals were detected (i.e., over 80 chemicals in sediment, and over 70 in surface water and surface soil). A screening of chemicals was therefore used in order to make the list of evaluated chemicals more manageable and to focus the ERA on the chemicals that are site-related and will contribute most to potentially significant ecological risks.

It should be noted that litter covering soils and detritus covering sediments was removed prior to sampling soil and sediment. Any contaminants present within the surface layer of partially decayed vegetation (i.e., leaves, twigs, etc.) were not accounted for in laboratory analyses. Therefore, analytical data reported are for concentrations of contaminants present in the underlying, soil, sediment or finer organic matter.

The methodology used to select COPCs at the Site is presented below:

- Prior to selecting COPCs, the data collected during this RI were summarized by environmental medium (i.e., surface soil, sediment, and surface water). In addition, the samples were divided into groups (presented above) by medium that describe environmental conditions relevant to the ERA (e.g., by exposure areas; Tables 7-2, 7-3, and 7-4, respectively). Grouping of the data allows for the characterization of environmental conditions relevant to exposure. For example, as described below, a group of background data can be used to determine if chemicals detected at or downgradient of a site are present at naturally occurring levels. Grouping data also helps in determining exposure point concentrations for receptor populations. For each medium, summary tables present chemical data by medium and sample grouping and contain parameters such as the frequency of detection, the mean concentrations, and the range of detected concentrations.

  Surface water data are presented for June and September, 1993. These sampling periods approximately represent high and low water flow conditions, respectively.

- As stated in the Work Plan (M&E, 1993a) and following EPA's *Risk Assessment Guidance for Superfund*(U.S. EPA, 1989h), the first screening procedure that was used in selecting chemicals for evaluation was the comparison of on-site inorganic concentrations to background inorganic concentrations. As stated in EPA Region I's *Guidance for Ecological Risk Assessments* (1989i), only those chemicals that "substantially exceed background concentrations" should be evaluated in the ecological risk assessment. This screening procedure eliminated chemicals from evaluation that may be naturally occurring and unrelated to past activities at the Site. Typically, site-specific background concentrations and concentrations detected at a site are statistically compared to determine if site levels are elevated above background levels.

At sites with a sufficient number of site-specific background samples, site concentrations can be compared to site background concentrations using statistical tests to determine if site levels are elevated above background levels. In the case of the Iron Horse Park Site, site-specific background data were available for surface soil, sediment, and surface water, the media of interest for the ERA. Only a limited number of site-specific background samples were available for these media (e.g., only three for surface soil and two for sediment/surface water). Based on this limitation, statistical tests to compare site to background concentrations were not deemed appropriate.

As an alternative to statistical comparisons, maximum site concentrations of inorganic chemicals were directly compared to maximum site-specific background concentrations. If the maximum concentration of an inorganic chemical in a site grouping exceeded the maximum background concentration, or if an inorganic chemical was detected in a site grouping but was not detected in relevant background samples, then that chemical was retained for further evaluation. Background comparisons are presented for surface soil, sediment, and surface water in Tables 7-8, 7-9, and 7-10, respectively.

- Following the comparisons to background, those chemicals in each medium that were detected in 5% or fewer of the site-wide samples were eliminated from the evaluation (Tables 7-5, 7-6, and 7-7) because they would be contacted by receptors only sporadically and/or by only a small percentage of a receptor population and would therefore be expected to contribute minimally to overall exposures associated with the Site.

- Essential animal nutrients (calcium, magnesium, potassium, and sodium) were then eliminated from the list of COPCs (Tables 7-2, 7-3, and 7-4) because they are unlikely to adversely affect ecological receptors at concentrations that usually occur in the environment.

- The chemicals remaining were then compared to toxicity screening criteria (Tables 7-8, 7-9, and 7-10). The sources of these screening criteria are briefly discussed below and listed in the order from which available values were selected. The addition of the screening criteria was necessary due to the large number of chemicals remaining in most media following the first three screens (i.e., background, frequency of detection, and essential animal nutrient). Screening criteria comparisons are presented for surface soil, sediment, and surface water in Tables

7-8, 7-9, and 7-10. Those chemicals with maximum detected concentrations below their screening criteria were eliminated as COPCs. Those chemicals with maximum detected concentrations above their screening criteria or those chemicals for which no screening criteria were available were selected as COPCs.

Surface Soil. Surface soil screening criteria, which were preferentially selected from the following sources, are presented later in Table 7-8:

- Toxicological benchmarks developed by Will and Suter (1994) for use at Department of Energy (DOE) sites
- Screening criteria cited in Beyer (1990)
- Screening criteria cited in the literature at large

The toxicological benchmarks (Will and Suter, 1994) developed for screening contaminants in surface soil for earthworms were selected first, as these benchmarks are one of the few standardized sources for evaluating earthworm toxicity. Will and Suter (1994) established these toxicity reference values (TRVs) at a level associated with a 20% reduction in growth, reproduction, or activity, which is consistent with other screening level benchmarks for ecological risk assessment and with the current regulatory approach (Suter, 1993). Because numerous chemicals still lacked screening values, some of the same screening criteria values that were used by M&E with EPA Region I oversight for other Superfund sites were then used. Many of these values were selected from Beyer's (1990) review of soil contamination. The Beyer (1990) values selected for use at the Iron Horse Park Site included acceptable soil levels, soil clean-up levels, and maximum allowable contaminant levels. It should be noted that many of these values are not earthworm-specific but have been derived for the protection of the environment or human health. Lastly, miscellaneous references specific for earthworms from the literature were used.

Sediment. Sediment screening criteria, which were preferentially selected from the following sources, are presented in Table 7-9:

- Ontario Ministry of Environment and Energy (1993) sediment quality guidelines for freshwater environments

- NOAA Effects Range-Low (ER-L) values for estuarine environments (NOAA, 1991, Long et al., 1995)

- Toxicological benchmarks developed by Hull and Suter (1994) for freshwater environments

- Sediment quality values derived by Barrick and Beller (1989) for estuarine environments

If available, sediment criteria used for sediment from the Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (OMEE, 1993) were given preference over other screening criteria. The criteria that were used represented the Lowest Effect Level (LEL), which is the concentration at which the majority of the sediment-dwelling organisms are not affected. The OMEE values were selected first because they are derived specifically for freshwater organisms, unlike some of the references discussed below (NOAA, 1991; Long et al., 1995; and Barrick and Beller, 1989).

If no OMEE sediment criterion was available for a given chemical, then NOAA ER-L values for marine and estuarine sediments (NOAA, 1991 and Long et al., 1995) were the next criteria selected for the sediment screening. These values are based on a review of effects-based criteria, including the equilibrium-partitioning approach, the spiked-sediment bioassay approach, and data from field surveys. The ER-L value is equivalent to the lower 10th percentile of the available toxicity data, which is estimated to be the approximate concentration at which adverse effects are likely to occur in sensitive life stages and/or species.

Toxicological sediment quality benchmarks (SQB) were developed by Hull and Suter (1994) for the screening of COPCs at DOE sites. This approach is based on the equilibrium partitioning approach and requires a water quality criterion (WQC; often an ambient water quality criterion [AWQC]) for input into the benchmark derivation equation below:

$$SQB = (K_{oc})(WQC)(\text{fraction organic carbon}) \quad (1)$$

The K_{oc} is the organic carbon-water partition coefficient. In cases where a WQC was not available, Hull and Suter used water quality benchmarks developed by Suter and Mabrey (1994) for use at DOE sites (see the surface water discussion below). A conservative fraction organic carbon content value of 1% was used given the nature of the screening process. It should be noted that organic carbon content values for the polar LELs are calculated by OMEE using 1% organic carbon content. In addition, organic carbon values typically associated with ER-Ls are 1%.

Barrick and Beller (1989) sediment toxicity values presented in terms of apparent effect thresholds (AETs), were given lowest preference for use as sediment screening criteria. An AET concentration is the sediment concentration of a selected chemical above which statistically ($P<0.05$) significant biological effects (e.g., depressions in the abundance of benthic infauna or elevated incidence of mortality in sediment toxicity tests) always occur (NOAA, 1991). Amphipod AETs, oyster AETs, benthic AETs, and Microtox AETs were available for some of the remaining nonionic organic compounds that lacked other screening values. The conservative fraction organic carbon content value of 1% was used.

Surface Water. Surface water screening criteria, which were preferentially selected from the following sources, are presented in Table 7-10:

- AWQCs (U.S. EPA, 1996q)
- Ecotox Thresholds (U.S. EPA, 1996b)
- LOELs (U.S. EPA, 1996g)
- Toxicological benchmarks developed by Suter and Mabrey (1994) for use at DOE sites

Although the State of Massachusetts provides quantitative guidance for certain water quality parameters (e.g., dissolved oxygen), it defers to EPA guidelines for the toxicity of chemicals. In all cases, available federal AWQC developed by U.S. EPA (1996g) were selected first. AWQC have been derived to prevent unacceptable toxic effects for 95% of all families of aquatic vertebrates, invertebrates, and plants (Stephen et al., 1985, U.S. EPA, 1986a), and therefore were regarded in this assessment to be the most appropriate screening criteria. Given the conservative nature of the screening process, the lowest detected hardness value in each surface water group was used to calculate AWQC for hardness-dependent AWQC (Table 7-11).

Ecotox Threshold (ET) benchmark values (U.S. EPA, 1996b) were used as the second source of surface water screening values. These values are chemical concentrations "above which there is sufficient concern regarding adverse ecological effects to warrant further site investigation" and have been developed for comparison to maximum site concentrations at Superfund sites. The EPA (1996b) notes that concentrations below these values should not result in significant adverse effects to ecological receptors. In addition, exceedances of the benchmark values also do not indicate the level or type of risk involved. These values are designed specifically as screening tools. Some of these values are the actual AWQC while others were calculated using the Great Lakes Water Quality Initiative Tier II methodology. This methodology is similar to that used by Suter and Mabrey (1994) which is described below. In fact, some of the ETs are from Suter and Mabrey (1994). The use of Tier II methodology is indicative of data sets that are not complete (less than eight families of aquatic organisms) for Tier I methodology (which is how AWQC are calculated), but are still adequate to generate a screening value.

In the absence of sufficient data to derive an AWQC, EPA often presents a Lowest Observed Effect Level (LOEL), which was used as the third source of screening criteria. Lastly, toxicological benchmarks developed to screen COPCs in aquatic habitats of DOE sites were used. These benchmarks are concentrations that would be expected to be higher than AWQC in no more than 20% of cases and were developed for chemicals that lack sufficient data with which to derive an AWQC.

7.1.2.4 Summarization of Data and COPCs. This section discusses the results of the data analysis, including the types of chemicals detected in each surface soil group and contaminant trends. The COPCs selected for further analysis are presented in Tables 7-12, 7-13, and 7-14. It is important to recognize that the selection of a chemical as a COPC does not necessarily indicate that it poses a risk to ecological receptors. The selection of a chemical only indicates that there is a need to evaluate that chemical in the risk assessment to determine if the chemical could result in potential risks to ecological receptors.

Surface Soil. Table 7-15 indicates the COPC groups and the number of COPCs selected in each surface soil group. Based on the review below, the B&M Railroad Landfill and the Contaminated Soil Area are the most contaminated surface soil groups at the Site. Both of these areas contained numerous PAHs and pesticides at the most elevated concentrations. The B&M Locomotive Shop Disposal Areas (A and B) appears to be the next most contaminated area, followed by the Old B&M Oil/Sludge Recycling Area. Based on the analytical data, the RSI Landfill appears to be the least contaminated surface soil group.

B&M Railroad Landfill. The B&M Railroad Landfill had the greatest number of COPCs selected in a surface soil group (33). Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and inorganics were selected as COPCs from this area, however, the majority of COPCs were from the latter three classes, with the SVOCs having the most COPCs (16). This is not unexpected, as many of the SVOC COPCs are PAHs and would be expected to occur in more industrialized areas, such as the B&M Railroad Landfill. The highest frequencies of detection (14/14) for the SVOCs were for the PAHs (i.e., benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene). The highest average and maximum concentrations of the PAHs were for benzo(b)fluoranthene. Methylene chloride, the only VOC selected as a COPC, was also detected at the highest frequency of the three VOCs detected in surface soil at the B&M Railroad Landfill. Although 11 pesticides were detected at frequencies of at least 50%, the pesticide COPCs with the highest frequencies of detection were DDT, endrin, and methoxychlor. Ten inorganics were selected as COPCs in surface soil at the B&M Railroad Landfill. The frequency of detection for these inorganic COPCs ranged from 1/14 to 14/14. However, the majority of inorganic COPCs were detected in 8/14 samples or greater.

RSI Landfill. The RSI Landfill, in comparison to the B&M Railroad Landfill, had relatively few COPCs (6). The COPCs included VOCs, pesticides, and inorganics. Methylene chloride, the only VOC detected at the RSI Landfill, was selected as a COPC, and had a frequency of detection of 2/6. The number of SVOCs detected at the RSI Landfill was substantially lower than at the B&M Railroad Landfill (6 versus 20, respectively), and none was selected as a COPC. Three of the nine detected pesticides, endrin, endrin ketone and methoxychlor, were selected as COPCs. The frequencies of detection for these pesticides ranged from 3/6 to 4/6. Chromium and iron, the only two inorganics selected as COPCs, were detected at frequencies of 4/6 and 6/6, respectively.

B&M Locomotive Shop Disposal Areas. The B&M Locomotive Shop Disposal Areas had 20 COPCs, including VOCs, SVOCs, pesticides, and inorganics, which were selected for further evaluation. Methylene chloride, the only VOC detected at the B&M Locomotive Shop Disposal Areas (A and B), was selected as a COPC and was detected in 2/5 samples. Eight of 20 detected SVOCs were selected as COPCs with frequencies of detection ranging from 1/5 to 5/5; most of the SVOC COPCs were PAHs. Phenanthrene was the only SVOC COPC detected in every sample. Four of the 14 detected pesticides, aldrin, endrin, endrin ketone and methoxychlor, were selected as COPCs. The frequencies of detection for these chemicals ranged from 1/5 to 5/5. Endrin was the only pesticide COPC detected in every sample. Seven inorganic COPCs were selected with frequencies of detection ranging from 1/5 to 5/5. Iron, copper, and zinc were the inorganic COPCs detected in every sample.

Old B&M Oil/Sludge Recycling Area. No COPCs were selected for quantitative evaluation in the Old B&M Oil/Sludge Recycling Area due to lack of ecological receptors. The detected chemicals were quite similar to those detected in the B&M Railroad Landfill, RSI Landfill, and the B&M Locomotive Shop Disposal Areas (A and B). Only one VOC, carbon disulfide, was detected in this surface soil group. Fifteen SVOCs were detected, the majority of which were PAHs. Concentrations of PAHs were typically an order of magnitude less than those detected at the B&M Railroad Landfill and B&M Locomotive Shop Disposal Areas (A and B). Nine pesticides were detected, with the majority detected in only 1/6 surface soil samples. Seventeen inorganics were detected, with 12 of the inorganics being detected in every sample.

Contaminated Soil Area. As with the Old B&M Oil/Sludge Recycling Area, no COPCs were selected for quantitative evaluation in the Contaminated Soil Area due to lack of ecological receptors. Chemical contamination in this surface soil group is the most widespread. Three VOCs, 25 SVOCs, 19 pesticides, and 20 inorganics were detected in surface soil. At least one chemical from each class was detected in over 70% of the samples. Methylene chloride was the most frequently detected VOC (34/46). Fluoranthene and pyrene were the most frequently detected PAHs, occurring in over 90% of the samples. The concentrations of PAHs appear to be the same order of magnitude as those in the B&M Railroad Landfill; this is not unexpected, given the proximity of the Contaminated Soil Area to the old B&M Railroad Landfill. Numerous pesticides were detected, with DDT and its breakdown products, DDD and DDE, being the most frequently detected. Eight of the 20 detected inorganics were detected in every sample (46/46).

Sediment. Table 7-16 indicates the COPC groups and the number of COPCs selected for each group in sediment. Although more VOCs were detected and selected as COPCs in sediment than in either surface soil or surface water, the COPCs in sediment were still primarily SVOCs, pesticides, and inorganics. PAHs were the most frequently detected SVOCs. DDE was the most commonly observed pesticide. Many of the inorganics (e.g., aluminum, barium, iron, manganese, and vanadium) were detected in the majority of sediment samples and were selected as COPCs. Those sediment groups that contained more lentic (standing water) sampling areas (Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland) had the greatest number of COPCs. The two areas characterized primarily as lotic (flowing water), West Middlesex Canal and East Middlesex Canal, contained the fewest sediment COPCs. The difference in number of COPCs is expected, given that the sediment/toxicant retention capabilities of lotic habitats are typically less than those of the lentic groups.

West Middlesex Canal Group. Thirty-six chemicals, including VOCs, SVOCs, pesticides, PCBs, and inorganics were selected as COPCs in West Middlesex Canal Group sediment. 2-Butanone, detected in only 1/13 sediment samples, was the only VOC selected as a COPC. Nine SVOCs were selected as COPCs, all but two being detected in fewer than 50% of the samples. With the exception of butylbenzylphthalate, all of the SVOCs selected as COPCs were PAHs. Nine pesticides and one PCB congener were selected as COPCs, and the frequencies of detection for all but four of these chemicals were less than 50%. Sixteen inorganics were selected as COPCs, with 10 of the 16 being detected in over 50% of the samples. Aluminum, barium, iron, manganese, and vanadium were detected in every sample.

Wetland 2 Group. Fifty-two chemicals, including VOCs, SVOCs, pesticides, PCBs, and inorganics were selected as COPCs in sediment from the Wetland 2 Group. 2-Butanone, the only VOC selected as a COPC, was detected in 6/27 sediment samples. Twenty-one SVOCs were selected as COPCs, with eight having frequencies of detection less than 50%. With the exception of butylbenzylphthalate, carbazole, 4-methylphenol, and n-nitrosodiphenylamine, all of the SVOCs selected as COPCs were PAHs. Ten pesticides and two PCBs were selected as COPCs, and the frequencies of detection for all but DDD and DDE were less than 40%. Eighteen inorganics were selected as COPCs, with six of the 18 being detected in fewer than 50% of the samples. Aluminum, arsenic, barium, iron, lead, manganese, and vanadium were detected in every sample.

East Middlesex Canal Group. Fifteen chemicals, including VOCs, SVOCs, pesticides, and inorganics, were selected as COPCs in sediment of the East Middlesex Canal Group. Acetone and 2-butanone were the VOCs selected as COPCs in sediment. These VOCs were detected at frequencies of 6/11 and 2/11, respectively. Although 11 SVOCs were detected in sediment, none was selected as a COPC. Five pesticides were selected as COPCs, with DDD and DDE having frequencies of detection over 50%, and the remaining pesticide

COPCs having frequencies of detection lower than 20%. Eight inorganics were selected as COPCs, with only mercury and selenium detected in fewer than 50% of the samples. Barium, manganese, and vanadium were detected in every sample.

Richardson Pond Group. Fifty chemicals, including VOCs, SVOCs, pesticides, and inorganics, were selected as COPCs in sediment of the Richardson Pond Group. Five VOCs (acetone, benzene, 2-butanone, 1,2-dichloroethene [total], and xylenes [total]) were selected as COPCs, with benzene, 1,2-dichloroethene, and xylenes detected in fewer than 20% of the samples. Eighteen SVOCs were selected as COPCs with 11 of the 16 having frequencies of detection less than 50%. The majority of the SVOC COPCs were PAHs, with benzo(b)fluoranthene, fluoranthene, phenanthrene, and pyrene being the most frequently detected. Ten pesticides were selected as COPCs, with only DDD and DDE detected in over 50% of the samples. Seventeen inorganics were selected as COPCs, with aluminum, barium, iron, lead, and manganese being the most commonly occurring inorganic COPCs.

Content Brook Wetland Group. Forty chemicals, including VOCs, SVOCs, pesticides, and inorganics, were selected as COPCs in sediment of the Content Brook Wetland Group. Acetone, 2-butanone, and xylenes (total) were the three VOCs selected as COPCs in sediment, all with frequencies of detection less than 40%. Sixteen SVOCs, primarily PAHs, were selected as COPCs. The frequencies of detection for the SVOC COPCs were all lower than 50%, with the exception of fluoranthene, naphthalene, phenanthrene, and pyrene. Eight pesticides were selected as COPCs, with frequencies of detection less than 30%, except for DDD and DDE. Twelve inorganics were selected as COPCs, with frequencies ranging from 2/14 to 14/14. Aluminum, arsenic, barium, iron, lead, and manganese were the most commonly occurring inorganics.

Surface Water. Table 7-17 indicates the COPC groups and the number of COPCs selected for each group during high (June 1993) and low flow (September 1993) conditions in surface waters of the Site. The COPCs selected in both flow conditions were evaluated quantitatively. As with sediment, the two surface water groups where the majority of samples were collected in stream (i.e., West Middlesex Canal Group and East Middlesex Canal Group) environments contained the fewest number of COPCs. The number of COPCs selected for the remaining three groups (Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland) was similar, although the Content Brook Wetland Group had the most COPCs. Given that surface water flow from the other four areas ultimately drains into the Content Brook Wetland, this finding was expected. As discussed below, the COPCs selected for surface water were primarily inorganics.

West Middlesex Canal Group. High Flow—One pesticide, aldrin, was selected as a COPC in surface water of the West Middlesex Canal Group during high flow conditions. Aldrin was only detected in 1/6 surface water samples.

Low Flow—No chemicals were selected as COPCs during low flow conditions in the West Middlesex Canal Group.

Wetland 2 Group. High Flow—Nine chemicals, including SVOCs, pesticides, and inorganics, were selected as COPCs in surface water of the Wetland 2 Group during high flow conditions. The majority of the COPCs (7 of 9) were inorganics. Chromium, copper, and mercury, were detected at frequencies of 13%, while barium, iron, lead, and zinc were detected at the highest frequencies. Pyrene and aldrin, the remaining COPCs, were both detected at low frequencies (2/15 and 1/15, respectively).

Low Flow—Ten chemicals, including SVOCs and inorganics, were selected as COPCs in surface water of the Wetland 2 Group during low flow conditions. Similar to the high flow conditions in the Wetland 2 Group, the majority (9) of the COPCs were inorganics. Pyrene was the only SVOC selected as a COPC, at a low frequency of detection (1/14). Copper, nickel, silver, and vanadium were four of the nine inorganic COPCs that were detected at frequencies below 15%. Barium, chromium, iron, lead, and zinc were detected at the highest frequencies, with barium and iron present in all samples.

East Middlesex Canal Group. High Flow—One pesticide, methoxychlor, was selected as a COPC in surface water of the East Middlesex Canal Group during high flow conditions. Methoxychlor was detected in 1/6 surface water samples.

Low Flow—No chemicals were selected as COPCs during low flow conditions in the East Middlesex Canal Group.

Richardson Pond Group. High Flow—Eight chemicals, including SVOCs and inorganics, were selected as COPCs in surface water of the Richardson Pond Group during high flow conditions. Similar to the high and low flow conditions in the Wetland 2 Group, the majority (7) of the COPCs were inorganics. Cobalt, mercury, silver, and zinc were detected at a frequency of about 13%. Barium, iron, and lead were detected at the highest frequencies. Pyrene was the only SVOC selected as a COPC, at a frequency of detection of 2/8.

Low Flow—Twelve chemicals, including SVOCs, pesticides, and inorganics, were selected as COPCs in surface water of the Richardson Pond Group during low flow conditions. Similar to the high flow conditions in the Richardson Pond Group, the majority (10) of the COPCs were inorganics. Chromium and copper were detected at a frequency of 14%. Aluminum, barium, iron, lead, selenium, silver, vanadium, and zinc were detected at higher frequencies than chromium and copper. Pyrene was the only SVOC selected as a COPC, at a low frequency of detection (1/7). Unlike the high flow conditions in the Richardson

Pond, one pesticide, DDD was selected as a COPC. It was detected in only 1/7 surface water samples.

Content Brook Wetland Group. High Flow—Eighteen chemicals, including VOCs, SVOCs, pesticides, and inorganics, were selected as COPCs in surface water of the Content Brook Wetland Group during high flow conditions. Similar to both the Wetland 2 Group and the Richardson Pond Group, the majority (14) of the COPCs were inorganics. Copper was detected at a frequency of 14%. Barium, iron, and manganese were detected at the highest frequencies. Xylenes (total), detected in 2/7 samples, were the only VOC selected as a COPC. Pyrene was the only SVOC selected as a COPC, at a frequency of detection of 1/7. Two pesticides, aldrin and gamma-chlordane, both detected in 1/7 samples, were selected as COPCs.

Low Flow—Nine chemicals, including pesticides and inorganics, were selected as COPCs in surface water of the Content Brook Wetland Group during low flow conditions. The majority (8) of the COPCs were inorganics. Copper was only detected as a frequency of 14%. Barium and iron were detected at the highest frequencies (7/7) during low flow conditions in the Content Brook Wetland. Alpha-chlordane was the only pesticide selected as a COPC, at a low frequency of detection (1/7).

7.1.3 Potential Exposure Pathways

Section 7.1.1 of the ERA provided a general overview of the habitats and ecological resources likely to occur at the Site. section 7.1.2 identified the COPCs for evaluation in the ERA. This section of the ERA describes the potential pathways by which ecological receptors at the Site could be exposed.

An exposure pathway is the route that a chemical takes from the source to the receptor. Potential exposure pathways for ecological receptors were identified based on the consideration of (1) the source/mechanism of chemical release; (2) the medium (or media) of chemical transport; (3) the point of potential contact by the receptor organism; and (4) the route of exposure at the contact point. Potentially complete exposure pathways and potential receptor groups were identified based on site ecology.

7.1.3.1 Plants. Terrestrial and aquatic plants rooted in contaminated soils or sediments may take up contaminants present in media pore water, whereas free floating plants such as duckweed may take up contaminants directly from the surface water. A secondary route of exposure entails absorption of gaseous contaminants or contaminants deposited on leaf surfaces.

The potential impact of site contamination on plants inhabiting the Site was not evaluated for two reasons. First, no direct evidence of vegetative loss or impairment has been observed; adverse effects on vegetation would be considered ecologically significant only if the severity of impact was great enough to affect habitat value for wildlife. Second, there are no known occurrences of protected plant species at the Site.

7.1.3.2 Terrestrial Animals. Soil invertebrates inhabiting the Site, such as earthworms, beetles, and ants, could be exposed to SVOCs, pesticides, and inorganics in surface soil via dermal absorption and the ingestion of contaminated soil, detritus, and animal matter. Earthworms directly ingest large quantities of soil and detritus. Due to significant direct contact with soil, many invertebrates will likely have significant exposures.

Soil invertebrates that bioaccumulate inorganic and/or organic COPCs may serve as a medium of contaminant transfer to higher trophic orders. Many birds and mammals such as American robin, deer mouse, and northern short-tailed shrew consume soil invertebrates at the Site. In turn, higher order consumers in the food chain such as hawks may consume birds and small mammals that contain contaminant body burdens.

Terrestrial wildlife may also be exposed to COPCs via incidental ingestion of soil or surface water, inhalation, or absorption through dermal surfaces. Although the quantity of soil ingested during foraging, preening or grooming activities may be relatively small, impacts can be significant when contaminant concentrations are high. The ingestion of dietary water is also a complete exposure pathway for terrestrial wildlife inhabiting the Site.

Inhalation and dermal absorption were not evaluated for terrestrial vertebrates at the Site. Although the inhalation pathway can be significant for burrowing animals such as woodchucks, the low number of VOCs found in soil areas indicate that exposure via inhalation would be limited.

Likewise, exposure to wind-blown contaminants in air is of limited importance because many of the soil areas from which samples were collected are stabilized with vegetation. Dermal absorption was not evaluated because, relative to ingestion, it not likely to significantly contribute to exposures.

7.1.3.3 Aquatic/Semi-aquatic Receptors. Aquatic invertebrates inhabiting the Site, such as amphipods, oligochaetes, and the aquatic life stages of terrestrial insects, could be exposed to SVOCs, PCBs, pesticides and inorganics in sediment and surface water. Routes of exposure include direct ingestion of abiotic media, ingestion of contaminated tissue, and dermal absorption. As was discussed for the terrestrial community, invertebrates are a prey base. At the Site, aquatic invertebrates are consumed by fish, amphibians, reptiles, and birds. As such, bioaccumulated contaminants may ultimately be transferred up the food chain to top predators (e.g., to great blue herons).

As indicated, vertebrates inhabiting the water resources at the Site may be exposed to site contaminants via ingestion of contaminated tissue and/or abiotic media. Although vertebrates may be exposed dermally to contaminants, this pathway was not evaluate at the Site because, relative to ingestion, it is not likely to significantly contribute to exposures.

7.1.4 Selection of Receptor Species

The approach used to assess potential ecological impacts is conceptually similar to that used to assess human health risks, in that potentially exposed populations (receptors) are identified, and then information on exposure and toxicity are combined to derive estimates of risk. However, the scope of ERAs is generally different from human health assessments in that an ecological assessment focuses on potential impacts in a population or higher level order of organisms rather than on the individual organism (except in the case of protected species where individuals are considered). In addition, because natural systems are comprised of a variety of species, ecological assessments evaluate potential impacts in numerous species instead of a single species (as is the case in human health assessments).

The selection of receptor species or groups is driven by a number of factors, including: (1) potential for exposure (e.g., based on habitat and feeding preferences); (2) sensitivity (e.g., predatory birds and PCBs) or susceptibility (e.g., based on foraging strategies and position in the food web); (3) frequency of occurrence of the species; (4) availability of toxicity data; (5) ecological significance (e.g., role of the species in the community or in predator-prey relationships); (6) societal value (e.g., trust resources, commercially or recreationally important species); and (7) protection status. Each of these factors was considered in the selection of receptor species/groups at the Site.

Table 7-18 provides an overview of the potential terrestrial and aquatic life that could be exposed to chemicals, identifies the specific pathways selected for evaluation, and provides a brief rationale for the selection/exclusion of each potentially complete exposure pathway. The receptor species or species groups that were evaluated in the ERA are described below:

- **Earthworms** - Soil invertebrates, which are present in many of the upland areas at the Site, have significant direct contact with soil and are therefore likely to receive high contaminant exposures. Soil invertebrates are ecologically important because they serve as a prey base for higher trophic levels and play an important role in the cycling of nutrients and aeration of soils.

  Earthworms were chosen to evaluate the potential for impacts to the soil invertebrate community. They are present at the Site, are exposed to site contaminants via dermal absorption and the direct consumption of soil and detritus, and are known to be sensitive to many contaminants (Beyer, 1990; Beyer and Stafford, 1993; Laird and Kroger, 1981).

- **Short-tailed Shrews (*Blarina brevicauda*)** - Small terrestrial mammals that have either been observed at or are likely to inhabit the Site include shrews, mice, moles and voles. Significant contaminant exposure routes included ingestion of contaminated tissue, soil, and dietary water. In general, small mammals have rapid reproduction and growth rates. Consequently, they serve as a significant food base for many carnivorous wildlife species.

  Short-tailed shrew was chosen to evaluate the potential for impacts to the small mammal community. Shrews have high ingestion rates and significant contact with soils. Earthworms constitute a high proportion of the diet. As such, shrews are exposed to bioaccumulated compounds and COPCs present within the gastrointestinal tract of earthworms.

- **Great Blue Heron (*Andrea herodias*)** - Aquatic and semi-aquatic migratory birds observed at the Site include great blue heron, green-backed heron, wood duck, Canada goose and mallard. Significant contaminant exposure routes included ingestion of contaminated tissue, sediment and surface water. Water resources within migration corridors are of ecological importance because thousands of birds visit and/or utilize the Site for nesting.

Great blue heron was chosen to evaluate the potential for impacts to the aquatic and semi-aquatic migratory bird community. Great blue herons are ecologically significant because they are top predators in aquatic environments. Fish constitute a significant proportion of the diet of great blue heron. As such, herons are likely to receive significant exposure to inorganic and organic contaminants that are bioaccumulated though the food chain. Although the term migratory can imply limited exposures, these birds may spend from early spring to early fall at the Site, encompassing the breeding season.

- **Aquatic Life** - Aquatic life present at the Site includes aquatic invertebrates such as amphipods, oligochaetes and insects, salamander larvae, turtles, and fish. Aquatic life may be exposed to contaminants via dermal absorption and ingestion of tissue, sediment and water. Aquatic life serve as a prey base to higher trophic levels in both aquatic and terrestrial environments. Many aquatic organisms also play an important role in the breakdown of organic matter.

  Because many of the ecological benchmark values used for evaluating the aquatic community were derived based on toxicity results from a number of species and were intended to be protective of a percentage of community members, no specific aquatic species were selected for evaluation. Rather, the benchmark values were used to evaluate the condition of the aquatic life community in general.

7.1.5 Selection of Assessment and Measurement Endpoints

The evaluation of the potential for ecological effects to occur is one factor in the decision making process regarding the need for further investigation and/or remediation (Suter, 1993). As defined by U.S. EPA (1989 and 1992), the term endpoint refers to a characteristic of an ecological receptor that can be affected by exposure to a chemical. Endpoints are used in the ERA process to define ecological attributes that are to be protected (assessment endpoints) and to define a measurable characteristic of those attributes (measurement endpoint) that can be used to gauge the degree of impact that has occurred (or may occur). Assessment endpoints most often relate to attributes of biological populations or communities; individual-based assessment endpoints typically are relevant only if protected species are present. Measurement endpoints are related to the assessment endpoint, and are the effects that can be measured or observed (e.g., toxicity in fish bioassays). Measurement endpoints are most often used as surrogates for assessment endpoints because in many cases, the assessment endpoint cannot be readily measured or observed.

U.S. EPA (1989 and 1992) has established some general criteria to guide the selection of assessment and measurement endpoints for ERA. In general, assessment endpoints should have social relevance (i.e., be valued by the public) and biological relevance, be measurable or predictable, and be susceptible to the hazard or stress being evaluated. Measurement endpoints should be related to or predictive of the assessment endpoint, readily measurable, and appropriate to the exposure pathways, size, and temporal dynamics of the Site. The assessment and measurement endpoints selected for evaluation of terrestrial and aquatic habitats in the ERA are discussed below and presented in Tables 7-19 and 7-20, respectively.

7.1.5.1 Terrestrial Habitat Assessment and Measurement Endpoints.

- Evidence of significant reduction in soil invertebrate populations—The assessment endpoint for soil invertebrates was evidence of a significant reduction in soil invertebrate populations. Site hazard quotients were derived by calculating the ratio of surface soil concentrations to earthworm toxicity benchmarks (Table 7-19). The measurement endpoint was a comparison of site HQs to a reference HQ of 10. Hazard quotients greater than 10 for the average exposure case were indicative of the potential for significant reductions in soil invertebrate populations.

- Evidence of significant reduction in small mammal populations—The assessment endpoint for small mammals was evidence of a significant reduction in small mammal populations. Site HQs were derived by calculating the ratio of COPC dose from ingestion of earthworms, surface water, and soil, estimated by modeling, to shrew toxicity benchmarks (Table 7-19). The measurement endpoint was a comparison of site HQs to a reference HQ of 10. HQs greater than 10 for the average exposure case were indicative of the potential for significant reductions in short-tailed shrew populations.

7.1.5.2 Aquatic Habitat Assessment and Measurement Endpoints.

- Evidence of significant reduction in aquatic populations—The assessment endpoint for aquatic life was evidence of a significant decrease in aquatic populations. Site HQs were derived by calculating the ratio of surface water and sediment concentrations to toxicity benchmarks for water column and benthic receptors (Table 7-20). The measurement endpoint was a comparison of site HQs to a reference HQ of 10. HQs greater than 10 for the average exposure case were indicative of the potential for significant reductions in aquatic populations. A second measurement endpoint was a qualitative comparison of the abundance of macroinvertebrates on-site versus off-site.

- Evidence of significant reduction in migratory bird populations—The assessment endpoint for migratory birds was evidence of a reduced population of migratory birds. Site HQs were derived by calculating the ratio of the COPC dose from ingestion of aquatic organisms, surface water, and sediment, estimated by modeling, to great blue heron toxicity benchmarks (Table 7-20). The measurement endpoint was a comparison of site HQs to a reference HQ of 10. HQs greater than 10 for the average exposure case were indicative of the potential for significant reductions in great blue heron populations.

7.2 CHARACTERIZATION OF EXPOSURE

The purpose of the exposure assessment is to identify the concentration and/or dose of the COPCs to which ecological resources selected for evaluation in the ERA could be exposed. The following sections identify the exposure concentrations/doses selected for the evaluation of potential adverse effects to each of the ecological receptor groups/organisms. The receptor species that were selected for quantitative evaluation at the Site were earthworms, short-tailed shrew, great blue heron, and aquatic receptors, based on their presence at the Site, likelihood of exposure, and ecological importance (see section 7.1.4). Exposure pathways by which these receptor species may be exposed were discussed in section 7.1.3.

7.2.1 Earthworms

For COPCs in surface soil (0 to 1 foot), exposures to earthworms were evaluated at the B&M Railroad Landfill, RSI Landfill, and the B&M Locomotive Shop Disposal Areas (A and B). Potential risks to earthworms were evaluated by comparing the exposure point concentrations in surface soil to available TRVs for earthworms (see section 7.3). As discussed previously, the Old

B&M Oil/Sludge Recycling Area and the Contaminated Soil Area were not quantitatively evaluated due to lack of ecological receptors.

Chemical concentrations in surface soil were summarized in section 7.1.2.4. For this medium, the arithmetic mean concentration was used to estimate average exposures for the selected receptor, because the ecological assessment focused on adverse effects in the population or community rather than on the individual organism. Average exposures are more appropriate than maximum exposures for estimating adverse effects to populations because the majority of the population is unlikely to be exposed to the maximum detected concentrations. However, the maximum detected concentration was also used in the comparisons, as an upper bound indicator of risk. Note that current and future uses of the Site by ecological receptors were assumed to be the same, therefore, separate exposures for current and future conditions were not calculated.

7.2.2 Short-tailed shrew

The following discussion presents the methods used to calculate the potential ingestion of COPCs by short-tailed shrews via the ingestion of food (i.e., earthworms), surface water, and surface soil. The ingestion of SVOCs, pesticides, and inorganics was evaluated. VOCs, because they are not known to bioaccumulate, were not evaluated in this pathway. The equations presented below were derived based on equations presented in U.S. EPA (1993). The surface soil groups for which small mammal ingestion pathways were evaluated included the B&M Railroad Landfill, RSI Landfill, and the B&M Locomotive Shop Disposal Areas (A and B).

The following equation was used to calculate the dose of each surface soil COPC that a shrew would be expected to obtain from the ingestion of earthworms:

$$Dose_{worm} = FI * C_{diet} \quad (2)$$

where

$Dose_{worm}$ = amount of COPC ingested per day via the ingestion of worms (mg/kg bw-d);

FI = food ingestion rate (kg/kg bw-d);

C_{diet} = estimated COPCs concentration in diet (mg/kg).

A food ingestion rate (FI) of 0.620 kg/kg bw-d reported in wet weight by U.S. EPA (1993) for adult shrews was used in the ERA. A fraction ingested term was not used in equation (2) because it was assumed to be 1.

The estimated dietary concentration (C_{diet}) was calculated using the following equation:

$$C_{diet} = P_e * C_e \quad (3)$$

where

P_e = proportion of diet consisting of earthworms (unitless);

C_e = estimated concentration of COPCs in earthworms (mg/kg).

The proportion of the diet (P_e) consisting of earthworms was based on information obtained from the scientific literature. Whitaker and Ferraro (1963 in U.S. EPA, 1993) found a shrew's diet to be comprised of 31.4% earthworms (% volume) in a study conducted during the summer (June through October) in New York state. In another eastern United States study, Hamilton (1941 in U.S. EPA, 1993) found that, over all seasons, 41% of the prey items in the gut were annelids (measured as frequency of occurrence). Based on these sources, it was conservatively assumed that 31.4% of the shrew diet is earthworms, this percentage is consumed year-round, and that all of the earthworms ingested are from the sampled areas of the Site. As the surface area of each surface soil group is larger than the foraging habitat of the short-tailed shrew, it was conservatively estimated that all foraging would occur within the boundaries of the respective surface soil group.

The remaining portion of the shrew's diet includes snails, slugs, fungus, insects, plant material, centipedes, arachnids, crustaceans, and small mammals (Hamilton, 1941; Whitaker and Ferraro, 1963). These items were assumed to not contain COPCs or to not contain COPCs at concentrations comparable to those of annelids. Of all the shrew prey items, annelids are the only group which feed exclusively by processing soils. It is assumed that greater level of exposure equates to greater body burdens. Uncertainty associated with this assumption is discussed further in Section 7.4.4 - Limitations and Uncertainties.

The concentration of each surface soil COPC in an earthworm (C_e) fresh weight was determined using the following equation:

$$C_e = C_{soil} * BCF \tag{4}$$

where

C_{soil} = average or maximum concentration of COPCs detected in surface soil (mg/kg dry weight);

BCF = wet weight bioconcentration factors for chemicals in earthworms (unitless).

Both the average and maximum concentration of each COPC in Table 7-2 were used to calculate earthworm COPCs concentrations. However, the average is more likely to be representative of exposures to mobile species like shrews. Earthworm bioconcentration factors (BCFs) found in the scientific literature are presented in Table 7-21.

The earthworm BCF value was multiplied by the average and maximum surface soil concentrations to estimate concentrations in the earthworm. For BCFs that were reported based on dry weight concentrations for earthworms, an adjustment to wet weight was necessary. The dry weight concentrations for earthworms were adjusted to wet weight by multiplying the result of equation (3) by a factor of 0.16, which was based on a report by Tyler (1973) indicating that 84% of an earthworm's fresh weight is water.

It is important to note that a relative oral bioavailability factor of one was assumed for each chemical evaluated in the ingestion pathways. The use of a factor of one is conservative because it assumes that 100% of the chemical ingested in the diet is bioavailable, and that bioavailability is similar to that of the bioassay from which the toxicity reference value (TRV) is derived. Furthermore, it assumes that there is no difference in uptake of a chemical between that of the receptor species and the species from which the TRV was derived.

In addition to the ingestion of chemicals accumulated in earthworms, shrews also may be exposed to chemicals through the ingestion of surface water. The following equation was used to calculate the dose of each COPC that shrews would be expected to obtain from the ingestion of surface water:

$$Dose_{sw} = SWI * C_{sw} \tag{5}$$

where

$Dose_{sw}$ =		amount of COPC ingested per day from surface water (mg/kg bw-d);
SWI	=	surface water ingestion rate (kg/kg bw-d);
C_{sw}	=	average or maximum COPC concentration in surface water (mg/l).

A surface water ingestion rate (SWI) of 0.223 kg/kg bw-d reported by U.S. EPA (1993) for adult shrews was used in the ERA. Note that surface water ingestion for shrews was only evaluated from the Wetland 2 Group because the B&M Railroad Landfill, RSI Landfill, and the B&M Locomotive Shop Disposal Areas (A and B) are all focused around or within the Wetland 2 Group. As a result, most surface water exposures for shrews in these three terrestrial habitats would be from the Wetland 2 Group. In addition, it was conservatively assumed that the shrew was ingesting water containing the highest average and maximum concentrations from either the high flow or low flow conditions. Table 7-4 presents surface water concentrations used in equation (4).

In addition to the ingestion of chemicals accumulated in earthworms and in surface water, shrews also may be exposed to chemicals through the inadvertent ingestion of surface soil while foraging or grooming. The following equation was used to calculate the dose of each COPC that shrews would be expected to obtain from the ingestion of soil:

$$Dose_{soil} = SI * C_{soil} \tag{6}$$

where

$Dose_{soil}$	=	amount of COPC ingested per day from soil (mg/kg bw-d);
SI	=	soil ingestion rate (kg/kg bw-d wet weight);
C_{soil}	=	average or maximum COPC concentration in surface soil (mg/kg dry weight).

Based on a percent dietary soil ingestion rate presented by Beyer et al. (1994) for opossum, it was assumed that 9.4% of the total mass of a shrew's diet is surface soil. The use of a percent surface soil ingestion value from opossum for shrews may be conservative because it is one of the highest values for mammals presented in Beyer et al. (1994). However, shrews consume great quantities of soil while foraging for earthworms. The percent soil ingestion was multiplied by the food ingestion rate (FI) presented earlier for this species to estimate soil ingestion rates (0.058 kg/kg bw-d for shrews). As for the calculation of the COPC concentrations in earthworms, the average and maximum COPC concentrations from Table 7-2 were used for C_{soil}.

The total dietary exposure levels to shrews for each surface soil COPC were determined using the following equation:

$$Dose_{total} = Dose_{worm} + Dose_{sw} + Dose_{soil} \tag{7}$$

Using the above equation, the estimated total dose of each COPC from the ingestion of each COPC in earthworms, surface water, and surface soil is presented in Table 7-22 for arithmetic mean exposures and Table 7-23 for maximum exposures. The total dietary intakes are compared to dietary toxicity values in the Risk Characterization (section 7.4) to determine if adverse effects are likely to occur to shrews from the ingestion of each COPC in earthworms, surface water, and surface soil.

7.2.3 Great Blue Heron

The following discussion presents the methods used to calculate the potential ingestion of COPCs by great blue heron via the ingestion of fish, surface water, and sediment. The ingestion of pesticides, PCBs, and inorganics was evaluated; VOCs, because they are not known to bioaccumulate, were not evaluated in this pathway. In addition, SVOCs (composed primarily of PAHs) were not evaluated in the fish ingestion pathway because available toxicity data suggest that PAHs in fish can be degraded to more polar metabolites and rapidly excreted. Thus, food chain biomagnification of PAHs appears to be limited (Neff, 1985 and Eisler, 1987). The intake of PAHs through consumption of dietary water and incidental sediment ingestion was evaluated, however. All five of the surface water/sediment groups were evaluated for arithmetic mean and maximum concentrations of surface water and sediment. The equations presented below were derived based on equations presented in U.S. EPA (1993).

The following equation was used to calculate the dose of each surface water/sediment COPC that a great blue heron would be expected to obtain from the ingestion of fish:

$$Dose_{fish} = FI * C_{diet} * SUF \tag{8}$$

where

$Dose_{fish}$	=	amount of COPC ingested per day via the ingestion of fish (mg/kg bw-d);
FI	=	food ingestion rate (kg/kg bw-d);
C_{diet}	=	estimated COPC concentration in diet (mg/kg);
SUF	=	site use factor (unitless).

A food ingestion rate (FI) of 0.18 kg/kg bw-d reported in wet weight by U.S. EPA (1993) for adult great blue heron was used in the ERA.

The estimated dietary concentration (C_{diet}) was calculated using the following equation:

$$C_{diet} = P_f * C_f \tag{9}$$

where

P_f = proportion of diet consisting of fish (unitless);

C_f = estimated concentration of COPC in fish (mg/kg wet weight).

The proportion of the diet (P_f) consisting of fish (100%) was based on information obtained from the scientific literature. U.S. EPA (1993) found a great heron's diet to be comprised primarily of fish, based on studies conducted throughout North America. A site use factor of 0.5 was used, given that great blue heron would likely occur at the Site for 6 months of the year (U.S. EPA, 1993). It was also assumed that great blue heron feed in uncontaminated areas while away from the Site when they are migrating.

Note that a fraction ingested term has not been used in equation (7) because it was assumed to be one. Similar to short-tailed shrews, a relative oral bioavailability factor of one was assumed for each chemical evaluated in the ingestion pathways.

No site-specific tissue residue data were available on the concentrations of COPCs in fish. However, the potential concentrations of pesticides and inorganics in fish were estimated from the concentration in surface water by using BCFs (Table 7-24). No PCB COPCs were identified in surface water.

The concentration of each COPC in fish was determined using the following equation:

$$C_f = C_{sw} * BCF \tag{10}$$

where

C_f = average concentration of COPC, as fresh weight (μg/kg);

C_{sw} = average concentration of COPC detected in surface water (μg/l);

BCF = bioconcentration factors for COPC in fish (unitless).

Both the average and maximum concentration of each COPC presented in Table 7-4 were used as C_{sw} in the model during both high and low flow conditions.

Movement of COPCs from sediment into fish was also evaluated. A steady-state compartmentalized food chain model developed by Thomann et al. (1992) was used to estimate concentrations of pesticides and PCBs in fish. Accumulation through two trophic levels was considered in the model: accumulation in benthic invertebrates from the ingestion of sediment, and accumulation in fish from the ingestion of benthic invertebrates. Biological parameters derived by Thomann (1989, 1992) were used for amphipods (*Pontoporeia affinis*) and bluegill (*Lepomis macrochirus*). Amphipods were assumed to feed exclusively on sediment/detritus and to comprise 100% of the diet of bluegill. The presence of amphipods was confirmed during the benthic reconnaissance surveys and bluegill were previously observed in the Site (Weston, 1989; M&E, 1995).

The uptake of inorganics into herons from sediment via benthos and fish was not evaluated for several reasons. The potential for inorganics to impact herons via the food chain is smaller than for the organic COPCs found at the Site. In addition, bioaccumulation factor (BAF) data are not as readily available for inorganics making the analysis more complex and results uncertain.

The chemical concentrations in each level of the food chain were determined using the following series of equations adapted from Thomann (1989) and Thomann et al. (1992). The concentrations of COPCs in amphipods was first calculated using the following equation:

$$\nu_1 = \frac{(\alpha_{1,s} * I_{LOC}) * r_s}{K_1 + G_1} \qquad (11)$$

where

ν_1 = average chemical concentration in amphipods (μg/kg lipid);

$\alpha_{1,s}$ = chemical assimilation efficiency (μg chemical absorbed/μg chemical ingested);

I_{LOC} = feeding rate of amphipods on sediment (g organic carbon ingested/g amphipod lipid content-d);

r_s = average chemical concentration in sediment (μg/kg organic carbon);

K_1 = chemical excretion rate (d^{-1});

G_1 = net growth rate (d^{-1}).

The average chemical concentration in organic carbon (r_s) used in Equation 10 above was derived using the following equation:

$$r_s = C_s / F_{oc} \qquad (12)$$

where

C_s = chemical concentration in sediment (μg/kg);

F_{oc} = fraction of organic carbon (kg organic carbon/kg sediment).

The concentration of chemicals in fish (ν_2) was determined using the following equation:

$$\nu_2 = \frac{\alpha_{2,1} * C_{2,1}}{K_2 + G_2} * \nu_1 \qquad (13)$$

where

ν_2 = chemical concentration in fish (μg/kg lipid);

$\alpha_{2,1}$ = chemical assimilation efficiency (μg chemical absorbed/μg chemical ingested);

$C_{2,1}$	=	specific consumption rate (g wet weight of amphipods/g wet weight of fish-d);
ν_1	=	average chemical concentration in amphipods (μg/kg lipid);
K_1	=	chemical excretion rate (d^{-1});
G_1	=	net growth rate (d^{-1}).

Attenuation factors, defined as the fraction of the source concentration (i.e., sediment or amphipod chemical concentration) that is translated to the receiving biota (i.e., amphipods and fish), are easily calculated using equations (10,11). Attenuation factors greater than 1 indicate chemicals likely to biomagnify in the food chain. Similarly, attenuation factors of less than 0.1 indicate chemicals not likely to magnify or accumulate in biota.

Concentrations of COPCs in sediment from the five sediment groups were input to equations (10,11). Average and maximum case scenarios were evaluated. Chemical consumption rates for each of the two species were determined from the literature. For amphipods, a sediment consumption rate (I_{LOC}) of 0.186 g organic carbon ingested/g amphipod lipid content-day was used (Thomann et al., 1992) and a fraction of organic carbon in sediment/detritus of 4.9% (Site average) was used. As previously mentioned, it was assumed that all of the diet was ingested from each sediment group in the Site. For bluegill, a consumption rate of 3.59% of the total body weight was used (Carlander, 1977). A specific consumption rate ($C_{2,1}$) of 1.96 kg wet weight of prey/kg wet weight of predator-day was determined.

Excretion rates (K_1 and K_2) were back calculated using an equation presented by Thomann (1989) for the sum of excretion and growth. Excretion and growth are the mechanisms by which the chemical concentration decreases within an organism. Excretion rates were calculated using the following empirically derived equation:

$$K + G = \frac{10^3 \left(\frac{\omega^{-0.25}}{p} \right) * E}{K_{ow}} + 0.01 * \omega^{-0.2} \qquad (14)$$

where

K	=	chemical excretion rate (d^{-1});
G	=	growth rate (d^{-1});
ω	=	wet weight of the organism (g wet weight);
p	=	lipid fraction of the organism (unitless);
E	=	chemical assimilation efficiency (equals α);
K_{ow}	=	octanol/water partition coefficient.

Biological parameters required for the above equations are summarized in Table 7-25. Chemical assimilation efficiencies (α) were determined using equations presented by Thomann (1989). These equations were derived based on linear regression of the chemical assimilation efficiency and the log K_{ow}. The chemical-specific log K_{ow} values, attenuation factors for each trophic level evaluated, and predicted COPC concentrations in amphipods and fish are shown in Table 7-26 for both the average and maximum cases. Predicted fish concentrations provided in µg/kg (lipid) were converted to body burdens by multiplying by the fraction lipid provided in Table 7-25. Thus, bluegill concentrations presented in Table 7-26 were multiplied by 0.022, the fraction lipid of bluegill.

In addition to the ingestion of COPCs accumulated in aquatic organisms, great blue heron also may be exposed to chemicals through the ingestion of surface water. The following equation was used to calculate the dose of each chemical that great blue heron would be expected to obtain from the ingestion of surface water:

$$Dose_{sw} = SWI * C_{sw} * SUF \qquad (15)$$

where

$Dose_{sw}$	=	amount of COPC ingested per day from water (mg/kg bw-d);
SWI	=	surface water ingestion rate (kg/kg bw-d);
C_{sw}	=	average or maximum COPC concentration in surface water (µg/l);
SUF	=	site use factor (unitless).

A surface water ingestion rate (SWI) of 0.045 kg/kg bw-d reported by U.S. EPA (1993) for great blue heron was used in the ERA.

In addition to the ingestion of COPCs accumulated in fish and in surface water, great blue heron also may be exposed to chemicals through the inadvertent ingestion of sediment while foraging or grooming. The following equation was used to calculate the dose of each COPC that great blue heron would be expected to obtain from the ingestion of sediment:

$$Dose_{sediment} = SI * C_{sediment} * SUF \tag{16}$$

where

$Dose_{sediment}$	=	amount of COPC ingested per day from sediment (mg/kg bw-d);
SI	=	sediment ingestion rate (kg/kg bw-d);
$C_{sediment}$	=	average or maximum COPC concentration in sediment (mg/kg);
SUF	=	site use factor (unitless).

Sediment ingestion data were not available in the scientific literature for great blue heron. As a result, it was conservatively assumed that a heron incidentally consumes an amount of sediment equivalent to 2% of the total mass of its daily diet. The percent sediment ingestion was multiplied by the food ingestion rate (FI) presented earlier for this species to estimate sediment ingestion rates (0.0036 kg/kg bw-d for great blue heron). As for the calculation of the COPC concentrations in fish, the average and maximum COPC concentrations were used for $C_{sediment}$.

The total dietary exposure levels for great blue heron to surface water/sediment COPCs were determined using the following equation:

$$Dose_{total} = Dose_{fish} + Dose_{sw} + Dose_{sediment} \tag{17}$$

Using the above equation, the estimated total doses from the ingestion of each COPC in fish, surface water, and sediment is presented in Tables 7-27 (arithmetic mean exposures during high flow conditions), 7-28 (arithmetic mean exposures during low flow conditions), 7-29 (maximum exposures during high flow conditions), and 7-30 (maximum exposures during low flow conditions). The total dietary intakes are compared to dietary toxicity values in the Risk Characterization (section 7.4) to determine if adverse effects are likely to occur to great blue heron from the ingestion of each COPC.

7.2.4 Aquatic life

Because most available aquatic toxicity data express toxicity as a function of concentration in the exposure medium (i.e., surface water or sediment), exposures to aquatic life were evaluated using benchmark chemical concentrations in surface water and sediment. Exposure point concentrations were estimated using the arithmetic mean of the environmental sampling data and the maximum detected concentration. Based on the mobility of most aquatic species and the transient nature of surface water, the average chemical concentrations measured in the surface water samples best represent the exposure concentration to which the aquatic life in a water body could be exposed. Maximum detected concentrations were also considered as an upper bound estimate of risk and to evaluate risk to sedentary benthic organisms. These concentrations were compared to TRVs in the Risk Characterization to estimate risk. Aquatic receptors were evaluated in all five surface water/sediment groups during both high and low flow conditions.

7.3 CHARACTERIZATION OF ECOLOGICAL EFFECTS

The ecological effects assessment focuses on earthworms, short-tailed shrew, great blue heron, and aquatic receptors because these groups were selected as potential receptor species or species groups. As discussed in section 7.2, potential adverse effects to these receptors were evaluated based on comparisons of chemical concentrations or doses in specific media to TRVs for representative species. This section discusses the toxicity criteria used in the ERA. In addition, toxicity profiles are presented in Appendix H for a subset of the COPCs, including aldrin, endosulfan, endrin, DDD, DDE, DDT, dieldrin, methoxychlor, PAHs, aluminum, antimony, arsenic, barium, copper, chromium, cyanide, iron, lead, manganese, and zinc.

The decision to produce toxicity profiles for the COPCs listed above was based on several factors. The first factor examined was frequency of detection for each COPC in each medium. Organic COPCs present at the highest frequencies in each medium were included in the list because their presence at the Site is widespread and they are more likely to contribute to population or community level effects than organic COPCs detected at lower frequencies. Toxicity profiles were prepared for inorganic COPCs exceeding their respective screening levels by the greatest amounts. In some cases, toxic COPCs without screening values were included in the list (e.g., cyanide). Each profile briefly discusses the aquatic and/or terrestrial toxicity of the COPCs. The aquatic section summarizes the toxicity ranges for aquatic invertebrates and fish. The terrestrial section summarizes the toxicity ranges for birds and mammals. The bioaccumulation potential of the COPCs in the terrestrial and aquatic food webs was also discussed in the toxicity profiles.

It is important to note that toxicity varies with the receptor species and with the availability and form of a given chemical. If a chemical is more bioavailable to an organism for absorption or uptake (such as through increased solubility in the sediment or surface water), then the toxic potential of the chemical increases. Availability and chemical form are affected by factors such as pH, temperature, moisture, microbial activity, organic carbon content, and complexation with other chemicals. In the absence of site-specific information on the bioavailability of the chemicals in surface soil, surface water, and sediment, it was assumed in this assessment that their bioavailability is similar to that seen in the toxicity studies reported in the literature. Thus, toxicity may be over- or underestimated depending in part on the extent to which site-specific chemical availability differs from those in studies reported in the literature.

Toxicity data in the scientific literature were reviewed to characterize the toxicity of the COPCs selected for evaluation. Toxicity values selected for the evaluation of the potential for adverse effects are referred to as TRVs and represent concentrations/doses of the COPCs that are protective of the ecological receptors being evaluated. In the absence of sufficient toxicity data for terrestrial receptors, TRVs were based on lowest levels or concentrations resulting in adverse effects, which then were modified by the application of uncertainty factors. The derivation of TRVs for terrestrial and semi-aquatic receptors is presented first, and is followed by the selection of TRV's for aquatic receptors. Benthic reconnaissance results are discussed in section 7.3.2.3.

7.3.1 Terrestrial and Semi-Aquatic Life

Potential adverse effects to earthworms and short-tailed shrews were evaluated based on comparisons of chemical concentrations or doses in soil to TRVs for representative species. Potential adverse effects to the great blue heron was evaluated based on comparisons of chemical concentrations or doses in sediment and surface water to TRVs for representative species. The derivation of TRVs for these receptors are presented below.

7.3.1.1 Earthworms. Section 7.1.2.3 discussed the rationale for selecting screening values for use in selecting surface soil COPCs. These screening values also were used as TRVs for earthworms in this ERA. As indicated in section 7.1.2.3, surface soil screening criteria were selected in the following order of preference: Will and Suter (1994); Beyer (1990); and the literature at large (see section 7.1.2.3 for specific details about the derivation of these TRVs). The earthworm TRVs were presented in Table 7-8, the surface soil COPCs screening table, and Table 7-39, which compares the earthworm TRVs to arithmetic mean and maximum concentrations within each surface soil group.

The TRVs developed by Will and Suter (1994) specifically for earthworms were not available for all soil analytes at the Site. Therefore, many of the TRVs were obtained from Beyer's (1990) review of soil contamination. The Beyer (1990) values selected for use at the Site included acceptable soil levels, soil clean-up levels, and maximum allowable contaminant levels. As discussed in section 7.1.2.3, it should be noted that many of these values are not earthworm-specific and therefore represent a source of uncertainty in the ERA.

Surface soil TRVs were not available for methylene chloride, acenaphthene, acenaphthylene, butylbenzylphthalate, carbazole, dibenzofuran, 2-methylnaphthalene, 4-methylphenol, aldrin, endrin, endrin aldehyde, endrin ketone, methoxychlor, cyanide, and iron. Thus, there are limitations associated with the evaluation of potential adverse effects on earthworms because the toxicity data base is limited.

7.3.1.2 Terrestrial and Semi-Aquatic Wildlife. Where available, toxicological benchmarks [i.e., estimated wildlife chronic no observable adverse effect levels (NOAELs)] were used to evaluate the potential for adverse effects to short-tailed shrews and great blue herons. Based on U.S. EPA (1994) guidance, chronic NOAELs are used as conservative estimates of the threshold level for effects, because organisms exposed over a long period to levels of a COPC below the NOAEL would not be expected to experience adverse effects. Opresko et al. (1994), which was published as part of remedial investigations at the Oak Ridge National Laboratory in Tennessee, summarizes the available literature data for many of the COPCs for both birds and mammals. However, additional literature searches were conducted for COPCs that were not addressed in Opresko et al. (1994). In the absence of values from Opresko et al. (1994), the following methodology was used to derive NOAELs for short-tailed shrew and great blue heron.

Short-Tailed Shrew. In most cases, toxicity data for shrews were not available. As a result, toxicity data were used for the most sensitive species for which bioassay data were available in the published literature. If the endpoint of the bioassay study from which the toxicity data were derived was not a chronic NOAEL, the following uncertainty factors were applied, as necessary, to extrapolate the available data to a chronic NOAEL (Opresko et al., 1994):

- a lowest observable adverse effect level (LOAEL) to a NOAEL: multiply by 0.1
- a 50% lethal dose (LD_{50}) to a NOAEL: multiply by 0.05
- subchronic study to a chronic study: multiply by 0.1

A LOAEL is the lowest dose of a COPC at which adverse effects were discernable. The LD_{50} is the dose of a COPC that was lethal to 50% of the test organisms during an acute study (usually less than 48 hours). A subchronic study is one in which the duration of the test exposure is not a significant proportion of the life span of the test animal (i.e., generally an exposure of less than 90 days), while the duration of the test exposure in a chronic study is generally greater than 90 days.

If data for a mammalian test species were not available but there were data for birds, the data for the avian test species were multiplied by an additional uncertainty factor of 0.1 to account for potential variation in toxicity between mammals and birds (Suter, 1993; Opresko et al., 1994). Toxicity data are generally expressed as the daily dose normalized to the body weight of the test animal (e.g., mg of chemical per kg body weight per day [mg/kg-day]). The normalization of toxicity data on a mg/kg-day basis allows comparisons among studies and among different test species. Studies have shown that resistance to toxic chemicals usually varies among different species as a function of body size. This occurs because various physiological functions, such as metabolic rates, are related to body size such that smaller species of mammals or birds have higher metabolic rates and are more resistant to toxic chemicals, because of more rapid rates of detoxification. It has been shown that the best measure of this variation between two different species can be expressed in terms of the cubed root of the ratio between the body weights of the two species (U.S. EPA, 1980). Therefore, a body size scaling factor (Opresko et al., 1994) was used to extrapolate the available toxicity data between the test species and a short-tailed shrew. The body size scaling factor is calculated as:

$$\text{Body Weight Scaling Factor} = \sqrt[3]{\frac{BW_t}{BW_r}} \qquad (18)$$

where BW_t is the mean body weight (wet) of the test species and BW_r is the mean body weight (wet) of the receptor species. Calculations for the body size scaling factors used for the short-tailed shrew are presented in Table 7-31. The derivation of the TRVs for the short-tailed shrew for the COPCs detected in surface soil and surface water is presented in Table 7-32. This table includes the test species from which the TRV was extrapolated and cites the literature sources of the data used to derive the TRV for each COPC.

Great Blue Heron. In most cases, toxicity data for the heron were not available in the published literature, and data were used for the most sensitive species for which there were published data. If the endpoint of the bioassay study from which the toxicity data were derived was not a chronic

NOAEL, the same uncertainty factors described for the short-tailed shrew were used to extrapolate the available data to a chronic NOAEL. If data for birds were not available but there were data for mammals, the data for a mammalian test species were multiplied by an additional uncertainty factor of 0.1 to account for potential variation in toxicity between mammals and birds (Suter, 1993, Opresko et al., 1994).

As described for short-tailed shrew, a body size scaling factor was used for extrapolation of the available data between the test species and a great blue heron. Calculations for the body size scaling factors used for the great blue heron are presented in Table 7-31. The derivation of the TRVs for the COPCs detected in surface water and sediment are presented in Table 7-33 for the great blue heron. This table includes the test species from which the TRV was extrapolated and cites the literature sources of the data used to derive the TRV for each COPC.

7.3.2 Aquatic Receptors

Exposures to aquatic life were evaluated using benchmark chemical concentrations in surface water and sediment. The method for selection of TRVs for aquatic life is presented below.

7.3.2.1 Sediment. Section 7.1.2.3 discussed the rationale for selecting screening values for use in screening sediment COPCs. Those screening values were used as TRVs for benthic organisms. As indicated in section 7.1.2.3, sediment screening criteria were preferentially selected from the following sources: Ontario Ministry of Environment and Energy (1993) sediment quality guidelines for freshwater environments; NOAA ER-L values for estuarine environments (NOAA, 1991, Long et al., 1995); toxicological benchmarks developed by Hull and Suter (1994) for freshwater environments; and sediment quality values derived by Barrick and Beller (1989) for estuarine environments. The sediment TRVs were presented in Table 7-9 (the sediment COPCs screening table) and Table 7-41 (comparison of the sediment TRVs to arithmetic mean and maximum concentrations within each sediment group).

It is important to note that using OMEE and NOAA values as TRVs for site-specific assessments is a source of uncertainty because it is not possible to adjust these values to account for differences in chemical bioavailability and chemical mixture composition that exist at a particular site. For instance, NOAA ER-L and OMEE LEL values cannot be adjusted for organic carbon. Typically, the environments from which the toxicity data were collected by NOAA had 1% organic carbon in sediment, which is less than the site-wide total organic carbon (TOC) at the Site (4.9%). In addition, LELs for non-polar organics were derived by OMEE using a TOC value of 1%.

When deriving toxicity reference values capable of incorporating site-specific TOC (e.g., Suter and Mabrey, 1994 and Barrick and Beller, 1989), the 4.9% Site average TOC was used. Chemicals where the toxicity values were affected by TOC included: acenaphthylene, benzene, butylbenzylphthalate, acetone, 1,2-dichloroethene (total), n-nitrosodiphenylamine, and xylenes (total).

Sediment TRVs were not available for 2-butanone, carbazole, endosulfan I, endosulfan II, endosulfan sulfate, 4-methylphenol, methoxychlor, aluminum, barium, beryllium, cobalt, selenium, and vanadium.

7.3.2.2 Surface Water. In a similar manner to surface soil and sediment, the surface water screening values presented in section 7.1.2.3 were used as surface water TRVs in the ERA. In most cases, with the exception of the hardness-dependent AWQC (see discussion below), these values were exactly the same as those presented in Table 7-10 (comparison of surface water concentrations to screening values). In addition, surface water TRVs were presented in Table 7-40, which compares the surface water TRVs to arithmetic mean and maximum concentrations within each surface water group. To summarize, surface water TRVs were preferentially selected in the following order: AWQCs (U.S. EPA, 1996g); Ecotox Thresholds (U.S. EPA, 1996b); LOELs (U.S. EPA, 1996g); and toxicological benchmarks developed by Suter and Mabrey (1994). Surface water TRVs were not available for aldrin and pyrene.

Criteria for copper, lead, nickel, and zinc are hardness-dependent. In calculating AWQCs, the average hardness value for the respective surface water group was used for the Wetland 2 Group, Richardson Pond Group, and the Content Brook Wetland Group. The average hardness values during high and low flow conditions were as follows: 64.6 and 68.8 mg/l $CaCO_3$ for the Wetland 2 Group; 69.1 and 77.6 mg/l $CaCO_3$ for the Richardson Pond Group; and 335 and 204 mg/l $CaCO_3$ for the Content Brook Wetland Group.

7.3.2.3 Benthic Reconnaissance Results. Macroinvertebrate samples were collected at sampling locations in each of areas of concern and from reference areas following Plafkin et al. (1989) (see also Figure 2-2). In general, the macroinvertebrates were identified to family and were counted. If greater than 50 individuals of a taxon were enumerated, the count was reported as >50. The habitat quality of each site was also evaluated by qualitatively assessing the following five habitat parameters: bottom scouring and deposition; pool/riffle, run/bend ratio; bank stability; bank vegetative stability; and streamside cover (Table 7-34).

Two types of aquatic habitats were observed among the sampling locations in which benthic macroinvertebrates were sampled. Lentic habitats were generally characterized by no flow and were located within a pond or unchannelized wetland. Lotic habitats were generally characterized by some flow, at least seasonally, and were located in a channelized area of a stream or wetland. Table 7-35 lists the reference and site-associated sampling locations that were included in each habitat type. Table 7-36 summarizes the physical characteristics of each sampling location, while Table 7-37 summarizes the surface water quality measurements for each sampling location.

The presence of Ephemeroptera, Plecoptera, and Trichoptera (EPT) were also characterized for the sampling locations. The absence of pollution-sensitive benthic invertebrates such as the EPT taxa is often an indicator of some impairment in the stream habitat. The only EPT taxa that were present in any site surface water/sediment group were Trichoptera (Table 7-38). However, this is likely the result of the low gradient and relatively warm water temperatures found at most sampling locations, and, as a result, indices based on EPT taxa did not provide much information on water quality among the benthic reconnaissance locations. Therefore, the number of taxa and the total number of individuals collected in each sample were enumerated. Also, the number of Mollusca and Amphipoda were compared among sampling locations to look for patterns of potential adverse effects within each area of concern.

In the West Middlesex Canal Group (MC-02, MC-03, MC-04), the macroinvertebrate communities seemed to be generally similar to the lotic reference locations and did not indicate any adverse effects, except at MC-02 (Table 7-38, Table 7-35). No Amphipoda were collected at MC-02, but this is probably related to low concentrations of dissolved oxygen (DO), as MC-02 had one of the lowest DO concentrations measured at any sampling location (Table 7-37).

In the Wetland 2 Group, the macroinvertebrate community at UB-02 was similar to that at the lentic reference locations. The macroinvertebrate communities at sampling locations UB-01 and UB-03 were also similar to that of the lotic reference locations. Sampling location UB-04 had fewer Amphipoda, but 17% of the organisms collected were EPT taxa, specifically Trichoptera, of which four of five individuals were Hydropsychidae or net-spinning caddisflies that require some current. This difference is related to the moderate current and more sandy, less organic sediments at UB-04 (Table 3), and does not indicate any adverse effects.

In the Richardson Pond Group, RP-01 differed from the lotic reference locations in that fewer individuals and fewer Amphipoda were collected. However, this sampling location had no flow and the DO concentration was low (Table 7-36, Table 7-37). Sampling location RP-03 was similar to the lentic reference locations, but fewer invertebrate taxa, fewer individuals, and no Mollusca were collected at RP-02. However, RP-02 had the lowest measured DO concentration of any sampling location (Table 7-37).

In the East Middlesex Canal Group, sampling location MC-05 was relatively similar in benthic composition to the lotic reference locations. Few taxa were collected at MC-09, but several Hydropsychidae were collected (10% EPT Organisms). As with UB-04, this difference was related to the moderate current and lower organic carbon content of sediments that characterized MC-09 (Table 7-36). Sampling location MC-10 was similar to the lotic reference locations in the number of taxa and individuals collected, but differed in that Diptera were the dominant taxa, instead of Amphipoda. However, many of these Diptera were in the family Ptychopteridae, which is characteristic of highly organic sediments, such as those described for MC-10 (Table 7-36), and does not indicate any adverse effects.

In the Content Brook Wetland Group, MC-06, MC-07, MC-08 were all similar in benthic composition to the lotic reference locations, and CB-03 was similar in benthic composition to the lentic reference locations. Sampling location CB-01 differed from the lotic reference locations in that fewer taxa, individuals, Mollusca, and Amphipoda were collected. There was no flow at CB-01, but no surface water data were available for this site to determine the possible influence of DO (Table 7-36, Table 7-37). Sampling location CB-02 differed from the lentic reference locations in that fewer taxa, individuals, and no Mollusca were collected, but the number of damselflies (i.e., Anisoptera) collected was the most of any site, except CB-03 (Table 7-38). This difference may be related to the relatively low DO concentration that was measured and to habitat characteristics, which were rated as only being fair (Table 7-36, Table 7-37).

In general, the macroinvertebrate surveys did not find any overt adverse effects that appeared to be related to site contaminants. Most of the effects appeared to be related to differences in DO concentrations, flow, and sediment characteristics. However, more subtle effects may not have been detectable because of the lack of replication, the low number of individuals collected at most sampling locations, the lack of a full analysis using a site-specific Index of Biotic Integrity (Plafkin et al., 1989), and dissimilarities in physical characteristics among the reference and site-associated sampling locations.

7.4 RISK CHARACTERIZATION

Risk characterization includes a description of the potential nature and magnitude of adverse effects that may occur to receptor species as a result of the presence of COPCs in the identified ecological habitats on or adjacent to the Site. In this step of the ERA, the characterization of exposure and ecological effects for each COPC are integrated into quantitative and qualitative estimates of the potential for adverse effects to ecological receptors.

7.4.1 Approach

Representative exposure concentrations/doses of the COPCs in each environmental medium were compared to chemical-specific TRVs. To quantify this comparison and characterize the potential ecological risk, hazard quotients (HQs) were calculated. For earthworms and aquatic receptors, the hazard quotient was calculated as:

$$\text{Hazard Quotient} = \frac{\text{Exposure point concentration}}{\text{TRV}} \tag{19}$$

For terrestrial and wetland avian and mammalian receptors, the hazard quotient was calculated as:

$$\text{Hazard Quotient} = \frac{\text{Calculated (estimated) exposure dose}}{\text{Toxicity reference dose}} \tag{20}$$

An HQ less than 1 indicates that there is little potential for adverse ecological effects associated with the observed concentration of a COPC. An HQ greater than 10 is indicative of the potential for significant reductions in populations of ecological receptors.

Although the HQs based on both the average concentration and maximum concentration are presented, the average concentration is generally considered most representative of exposure at the population or community level. However, the maximum concentration may be more representative of exposure for sedentary organisms or in cases where maximum concentrations occur within a resource area that is frequented by many animals (e.g., a water source or wetland/upland ecotone).

7.4.2 Characterization for Terrestrial and Aquatic Environments

The following subsections present the risk characterization for earthworms, aquatic receptors, short-tailed shrew, and great blue heron for each area of concern. The average HQ discussed in the following sections is the average exposure point concentration or dose divided by the TRV, whereas the maximum HQ is the maximum exposure point concentration or dose divided by the TRV.

In general, average exposure case HQs greater than 10 were interpreted as an indication of potential harm unless large uncertainties in the calculation of exposures and TRVs were identified. HQ greater than 10 were used as a trigger because TRVs that were derived for risk characterization are conservative, representing a concentration at which no adverse effects were observed (i.e., NOAEL). Therefore, in many instances a small exceedance of the TRV would probably not lead to negative impacts, whereas impacts would be anticipated with a 10-fold increase in dose.

In contrast to average exposure case HQs, maximum exposure case HQs greater than 10 were not generally interpreted as indicators of significant risk to receptor populations because, in most cases, only a small percentage of a population would be expected to be exposed to the maximum site concentrations. Where applicable, results from maximum exposure case analyses are discussed.

Hazard indices were also calculated for each class of contaminants (e.g., inorganics). Average and maximum hazard indices represent the sum of the average and maximum hazard quotients, respectively (Tables 7-44, 7-45, and 7-46). Situations where hazard indices support risk conclusions for individual compounds are identified.

7.4.2.1 Terrestrial Environments. For each area of concern the potential risk to populations of soil invertebrates and terrestrial mammals were evaluated from exposure to contaminants in surface soil. For each area of concern, each COPC or group of COPCs considered to contribute to risk are identified. A qualitative evaluation of ecological risk for the Old B&M Oil/Sludge Recycling Area and the Contaminated Soil Area is presented separately in section 7.4.3.

B&M Railroad Landfill. For the earthworm analyses, average HQs were greater than 10 for benzo(a)pyrene, chromium, and mercury (Table 7-42). These HQs over 10 indicate potential for significant reductions in soil invertebrate populations at the B&M Railroad Landfill from exposures to these COPCs. Benzo(a)pyrene (HQ=718) and chromium (HQ=185) had the highest HQs at the B&M Railroad Landfill (Table 7-39), suggesting that soil invertebrates would be at greatest risk from exposures to these two COPCs. Along with the depressed soil invertebrate populations, the prey base for species consuming soil invertebrates could be reduced and soil processes related to invertebrate function in decomposition and aeration could be disrupted. In addition to the individual COPC analyses, the average and maximum HIs were greater than 10 for both inorganics and SVOCs for ingestion of and dermal absorption from soil (Table 7-44). Thus, soil invertebrate populations are not only at risk from exposure to individual inorganics and SVOCs, but also to groups of inorganics and SVOCs.

Results of the short-tailed shrew food-chain analysis indicated that antimony (HQ=17), cadmium (HQ=28), dibenzo(a,h)anthracene (HQ=65), and iron (HQ=2,420) are the COPCs at the B&M Railroad Landfill for which average HQs were greater than 10 (Table 7-42). These results indicate potential for significant reductions in small terrestrial mammal populations at the B&M Railroad Landfill. Reductions in the small mammal populations could adversely affect predators of these organisms higher in the foodchain, such as hawks. In addition to the individual COPC analyses, the average and maximum HIs were greater than 10 for both inorganics and SVOCs for the soil ingestion and earthworm ingestion pathways (Table 7-44). Thus, these analyses indicate small mammal populations are not only at risk from exposure to individual inorganics and SVOCs, but also to groups of inorganics and SVOCs.

The results of the exposure pathways for the terrestrial environment indicated potential risk to soil invertebrate populations or small mammals due to exposures to metals (particularly antimony, cadmium, chromium and mercury) and SVOCs (benzo(a)pyrene and dibenzo(a,h)anthracene) from surface soils at the B&M Railroad Landfill. Although risk was indicated from exposure to high concentrations of iron, there is a large degree of uncertainty with the risk calculation for iron due to the lack of toxicity data for shrews and because risks from exposure to iron vary with the form that iron is present in the environment.

RSI Landfill. Chromium was the only COPC evaluated at the RSI Landfill indicating potential impact on earthworm populations, having an average HQ of 35 (Table 7-42). The only COPC with an HQ above 10 for the shrew analysis was iron (Table 7-42). Therefore, the ecological risk to the terrestrial ecosystem at the RSI Landfill is restricted mainly to potential reductions in invertebrate soil populations resulting from exposure to chromium. There is no indication of bioconcentration of chromium in the terrestrial food chain (Carey, 1982 in ATSDR, 1987i), and the exposure analysis for shrews resulted in an HQ for chromium of less than 1. Without further direct evidence of reductions in invertebrate or mammal populations, the weight of evidence from exposure to soil contamination does not indicate significant ecological risk at the RSI Landfill.

B&M Locomotive Shop Disposal Areas (Areas A and B). For the earthworm evaluation, average HQs were greater than 10 for benzo(a)pyrene, chromium, and copper (Table 7-42). Benzo(a)pyrene (HQ=101) and chromium (HQ=78) had the highest HQs at the B&M Locomotive Shop Disposal Areas (Table 7-39). Neither of the two metals had average HQs greater than 10 for the shrew analysis, which is expected since bioconcentration of both of these metals is insignificant in terrestrial habitats (Appendix H, Toxicity Profiles).

Results of the short-tailed shrew food-chain analysis indicated that antimony (HQ=14) and iron (HQ=2,386) are the COPCs at the B&M Locomotive Shop Disposal Areas (Areas A and B) for which average HQs were greater than 10 (Table 7-42). These results indicate potential reduction in small mammal populations at the B&M Locomotive Shop Disposal Areas (Areas A and B). Iron had the highest HQ in the B&M Locomotive Shop Disposal Areas (Areas A and B), although the uncertainty in evaluating the significance of the exposure to iron is high. The weight of evidence from the analyses of exposures to surface soil at the B&M Locomotive Shop Disposal Areas (Areas A and B) indicates potential risk to terrestrial food web, with potential effects on both invertebrate and small mammal populations. Reductions in the small mammal populations could adversely affect the predators of these organisms higher in the foodchain, such as hawks.

7.4.2.2 Aquatic Environments. For each area of concern the potential risk to aquatic life exposed to sediment and surface water is summarized and each COPC or group of COPCs considered to contribute to risk from each are identified. The potential risk from exposure of migratory birds (great blue heron) from ingestion of surface water, incidental ingestion of sediment and ingestion of fish within each area of concern are also presented.

West Middlesex Canal Group. There were no COPCs with HQs greater than 10 for aquatic receptors in the West Middlesex Canal Group from exposure to surface water (Table 7-43). Thus, a significant reduction in aquatic populations is not indicated to have occurred from exposures to individual COPCs. In addition, there were no HIs for aquatic receptors at the West Middlesex Canal Group greater than 10 (Table 7-45).

Average HQs were greater than 10 for benzo(a)anthracene (HQ=13), benzo(b)fluoranthene (HQ=16), benzo(k)fluoranthene (HQ=17), butylbenzylphthalate (HQ=19), chrysene (HQ=11), and 2-methylnaphthalene (HQ=57) for the benthic receptor evaluation in sediment (Table 7-43). Average and maximum HIs were greater than 10 for inorganics and SVOCs in multiple exposure pathways (Table 7-45). The maximum HQ was greater than 10 for Aroclor-1248 (Table 7-41), and the maximum HI was greater than 10 for pesticides (Table 7-46), indicating the possibility of potential ecological impacts, particularly to sedentary organisms on a limited spacial scale.

There were no COPCs with HQs greater than 10 for great blue heron in the West Middlesex Canal Group under both high and low-flow conditions (Table 7-43). Thus, a significant reduction in migratory bird populations is not indicated from this analysis. In addition, there were no HIs greater than 10 for the ingestion pathways (sediment, surface water, and fish) (Table 7-45).

Analysis of the potential ecological effects on the aquatic ecosystem in the West Middlesex Canal indicates no risk from exposure to surface water, but potential risk from exposure of benthic organisms to SVOCs in sediments and potentially, copper, lead, PCBs, and pesticides on a limited spacial scale. However, no direct effects on canal invertebrate populations were observed based on limited data collected at the Site. It is also important to note that high detection limits (referred to as sample quantitation limits; SQLs in previous sections) for PAHs with HQs greater than 10 likely resulted in an overestimation of average exposures.

Although the presence of COPCs in the canal could pose risks to aquatic and semiaquatic organisms feeding on invertebrates exposed to contaminants in sediments, HQs derived for the heron model did not indicate the potential for significant effects on a large piscivorous birds, leading to the conclusion of limited ecological impacts associated with exposure to COPCs in the canal.

Wetland 2 Group. Average HQs were greater than 10 for barium (HQ=16), iron (HQ=10), and lead (HQ=27) for the aquatic receptor evaluation in surface water (Table 7-43). Values of HQs over 10 indicate a potential for significant reduction in aquatic populations at the Wetland 2 Group from exposures to these COPCs. Barium and lead had the highest HQs at the Wetland 2 Group, suggesting that aquatic receptors would be at greatest risk from exposures to these two COPCs. A decrease in aquatic populations could adversely affect organisms higher in the foodchain. In addition to the individual COPC analyses, average and maximum HIs were greater than 10 for inorganics in multiple exposure pathways during both high and low flow conditions (Table 7-45). Thus, aquatic populations are not only at risk from exposure to individual inorganics, but also to inorganics as a group.

Average HQs were greater than 10 for acenaphthene (HQ=58), benzo(b)fluoranthene (HQ=13), copper (HQ=16), dibenzo(a,h)anthracene (HQ=25), and 2-methylnaphthalene (HQ=13) for the benthic receptor evaluation in sediment (Table 7-43). These HQs indicate potential for significant reduction in benthic populations in the Wetland 2 Group. Acenaphthene, dibenzo(a,h)anthracene, and copper had the highest average HQs for sediment in this group, suggesting that benthic receptors would be at greatest risk from exposures to these three COPCs. Of the four SVOCs, dibenzo(a,h)anthracene was the only compound for which exposures may have been overestimated due to high detection limits.

Average and maximum HIs were greater than 10 for inorganics, SVOCs, and pesticides in multiple exposure pathways (Table 7-46). Thus, benthic populations are at risk from exposure to copper and individual SVOCs, as well as from the combined impacts of inorganics, SVOCs, and pesticides. A decrease in benthic populations could adversely affect predators that prey upon these organisms, such as fish.

For the heron exposure evaluation, the HQs for dibenzo(a,h)anthracene (HQ=83) and mercury (HQ=96) (high flow, average exposure; Table 7-27), and dibenzo(a,h)anthracene (HQ=83) and zinc (HQ=14) (low flow, average exposure; Table 7-28) were all greater than 10 (Table 7-43), indicating potential for significant reduction in migratory bird populations from exposure to these COPCs. The only HQ for which any of the SVOCs evaluated exceeded 10 was dibenzo(a,h)anthracene. This result must be interpreted cautiously due to the uncertainty associated with high dibenzo(a,h)anthracene detection limits, and because the maximum HQ for dibenzo(a,h)anthracene was not greater than 10. Average and maximum HIs for herons were greater than 10 for inorganics (ingestion of fish) and SVOCs (ingestion of sediment) during both high and low flow conditions (Table 7-45). Thus, great blue heron are not only potentially at risk from exposure to mercury, zinc, and dibenzo(a,h)anthracene, but also to the combined effects of inorganics and SVOCs.

The highest HQ calculated for herons was for mercury (HQ=96). It is important to note that risks to heron from mercury may be even higher due to the fact that the contribution to mercury burden in fish from direct ingestion of sediment was not calculated in the ERA.

Evaluation of potential ecological risk for Wetland 2 Group, indicated potential reductions in benthic invertebrate populations due to exposure to SVOCs and copper in sediments. Aquatic receptors may also be at risk from exposure to metals (barium, iron and lead) in surface water. The analysis of the exposure of herons indicated the majority of the risk for migratory birds is associated with exposure to mercury and zinc via fish ingestion. In summary, weight of evidence suggests that ecological receptor populations in the Wetland 2 Group are at risk from COPCs.

East Middlesex Canal Group. There were no COPCs with HQs greater than 10 for aquatic receptors in the East Middlesex Canal Group (Table 7-43). Thus, a significant reduction in aquatic populations is not likely to occur in surface water of this area from exposures to individual COPCs.

The East Middlesex Canal Group was the least contaminated of the five sediment groups as no COPCs had HQs greater than 10 (Table 7-43). In addition, there were no COPCs with HQs greater than 10 for great blue heron in the East Middlesex Canal Group (Table 7-43). Thus, a significant reduction in migratory bird populations is not indicated. Overall, the ecological risk for exposure to COPCs in surface water and sediments in the East Middlesex Canal are minimal.

Richardson Pond Group. The average HQs were greater than 10 for barium (HQ=27), iron (HQ=26), and lead (HQ=11) for the aquatic receptor evaluation in surface water (Table 7-43). Average HQs over 10 are indicative of potential for significant reduction in aquatic populations at the Richardson Pond from exposures to these COPCs. In addition to the individual COPC analyses, average HIs were greater than 10 for inorganics in multiple exposure pathways during both high and low flow conditions (Table 7-45). Thus, aquatic populations are not only at risk from exposure to individual inorganics, but also to inorganics as a group.

For the benthic receptor evaluation in sediment, the average HQs were greater than 10 for the majority of SVOCs (Table 7-43). These HQs greater than 10 indicate potential for significant reduction in benthic populations in the Richardson Pond Group. Average exposures to 2-methylnaphthalene and dibenzo(a,h)anthracene may have been overestimated due to high detection limits.

Average HIs were greater than 10 for inorganics, SVOCs, and pesticides in multiple exposure pathways (Table 7-46). Thus, benthic populations are not only at risk from exposure to individual SVOCs, but also to the combined impacts of COPC inorganics, SVOCs, and pesticides. A decrease in benthic populations could adversely affect predators that prey upon these organisms, such as fish.

In the Richardson Pond Group, the HQs for dibenzo(a,h)anthracene (HQ=242) (high flow, average exposure; Table 7-27), and dibenzo(a,h)anthracene (HQ-242) and zinc (HQ=15) (low flow, average exposure; Table 7-28) were greater than 10, indicating significant potential for harm to migratory bird populations from exposure to these COPCs. Average HIs were greater than 10 for inorganics (ingestion of fish) during low flow and SVOCs (ingestion of sediment) during both high and low flow conditions (Table 7-45). It is important to note the maximum HQ for dibenzo(a,h)anthracene (HQ=166) was below the average HQ for this COPC (HQ=242). This occurred for dibenzo(a,h)anthracene because the average concentration was biased higher than the maximum by an order of magnitude due to high detection limits. Thus, the average HQ for dibenzo(a,h)anthracene may overestimate risks to migratory birds. Therefore, great blue heron are most likely at risk only from exposure to individual inorganics and also to inorganics as a group.

Evaluation of risks to receptors in the Richardson Pond Group indicated that aquatic receptors may be at risk from metals (particularly barium, iron, and lead) and benthic invertebrates may be at risk from individual SVOCs and the combined effects of inorganics, SVOCs and pesticides. In addition, migratory birds may be at risk from zinc and the combined effects of inorganic COPCs.

Content Brook Wetland Group. Average HQs were greater than 10 for aluminum (HQ=139), arsenic (HQ=12), barium (HQ=597), iron (HQ=357), manganese (HQ=44), and silver (HQ=43) for the aquatic receptor evaluation in surface water at Content Brook Wetlands (Table 7-43). These HQs over 10 indicate potential for significant reduction in aquatic populations at the Content Brook Wetland Group from exposures to these COPCs. Barium, aluminum, and iron had the highest HQs at the Content Brook Wetland Group, suggesting that aquatic receptors would be at greatest risk from exposures to these two COPCs. These results imply a potential for a decrease in aquatic populations which could adversely affect organisms higher in the foodchain. In addition to the individual COPC analyses, average HIs were greater than 10 for inorganics in multiple exposure pathways during both high and low flow conditions (Table 7-45).

The Content Brook Wetland did not have sediment risks as high as would be expected given that it directly or indirectly receives surface water discharge from all four other sediment groups. The only HQ greater than 10 for the benthic receptor evaluation in sediment was acenaphthene (HQ=19). Average HIs were also greater than 10 for inorganics and SVOCs in multiple exposure pathways. Thus, benthic populations are potentially at risk from exposure to acenaphthene and also from the combined effects of COPC inorganics and SVOCs. However, it is important to note that average exposures to acenaphthene may be overestimated due to high detection limits.

In the Content Brook Wetland Group the HQs for dibenzo(a,h)anthracene (high flow, average exposure [HQ=17] and low flow, average exposure [HQ=17]) were greater than 10 (Table 7-43), indicating potential for significant reductions in migratory bird populations to occur from exposure to this COPC. Average HIs were greater than 10 for inorganics (ingestion of fish) during high flow and SVOCs (ingestion of sediment) during both high and low flow conditions (Table 7-45). Most of the total risk for dibenzo(a,h)anthracene was contributed by incidental sediment ingestion by herons.

In summary, populations of aquatic receptors inhabiting the Content Brook Wetlands Group may be impacted by metals, and migratory bird populations may be impacted by dibenzo(a,h)anthracene and from the combined effects of inorganics and SVOCs. The degree of risk SVOCs pose to benthic invertebrates is uncertain.

7.4.3 Potential Risks from the Old B&M Oil/Sludge Recycling Area and the Contaminated Soil Area

As indicated in section 7.1, no COPCs were selected for quantitative evaluation in the Old B&M Oil/Sludge Recycling Area and the Contaminated Soil Area due to lack of ecological receptors. The absence of ecological receptors is primarily because both of these areas are unlikely to provide suitable habitat for terrestrial receptors (e.g., earthworms and shrews) due to the physical changes to the habitats from industrial activities. The Contaminated Soil Area is dominated by debris, railroad cinders, and rocks. Likewise, the Old B&M Oil/Sludge Recycling Area is partially covered by pavement. Both areas contain little habitat cover and limited ground cover. Earthworm populations are not expected to inhabit these areas. Without a prey base such as earthworms, shrews would also not be expected to use these areas to forage. As a result, there are no complete exposure pathways for terrestrial receptors in these areas, thus they were not quantitatively evaluated.

Given the presence of contaminants in both of these areas, there is potential for contaminant migration into more sensitive environments. This is especially the case for the Contaminated Soil Area, where contamination is widespread, and which is in close proximity to wetland environments.

However, any contaminant migration into more sensitive areas such as wetlands has been evaluated because these nearby areas were sampled in the RI and evaluated in the ERA (e.g., West Middlesex Canal Group and the Wetland 2 Group). If, in the future, the physical habitat quality does not preclude the presence of a significant soil invertebrate community, the elevated concentrations of contaminants in these areas, particularly the Contaminated Soil Area, could adversely affect establishment of soil invertebrates such as earthworms.

7.4.4 Limitations and Uncertainties

There is uncertainty associated with the estimates of ecological risk in any ERA, as the risk estimates are based on a number of assumptions regarding exposure and toxicity. A thorough understanding of the uncertainties associated with the risk estimates is critical to understanding predicted risks and to placing them in proper perspective. Important sources of uncertainty associated with the ERA for the Site are discussed below. In Section 7.4.4.5, the contribution to risk and the confidence in risk results for each contaminant are presented and described in tabular form.

7.4.4.1 Environmental Sampling. Uncertainties in environmental sampling are associated with the calculation of exposure point concentrations from sampling data. One-half of the reported detection limit was used for non-detected concentrations in the calculation of the arithmetic mean. Any approach dealing with non-detected chemical concentrations is associated with some uncertainty. This is because chemicals that were not detected at the specified detection limit may be absent from the medium or may be present at any concentration below the detection limit. Even if one-half of the detection limit was greater than the maximum measured value, which may bias the exposure point concentration estimate upwards, one-half the detection limit was still used to calculate the exposure point concentration. The presence of high detection limits caused the arithmetic mean concentration to exceed the maximum detected concentration several times (e.g., sediment). Situations where this occurrence influenced risk results have been identified in the document.

7.4.4.2 Exposure Estimation. The exposure estimates for Site receptor species are a source of uncertainty in the ERA. Values for exposure parameters (e.g., body weight, food intake rate, home range) were based on literature values, not site specific data. For instance, it was assumed, based on other studies, that 31.4% of the shrew diet is comprised of annelids. It was also assumed that shrews consume annelids throughout the entire year, and that contaminant body burdens in annelids are far greater than would be found in any of the other prey items shrews typically consume. The accuracy of each of these assumptions relative to the Site may be debated. One way to address the most uncertain of these assumptions is to remodel shrew exposure with more conservative parameter values and then evaluate how the risk results would have changed had these more conservative parameter values been used. For the shrew exposure model, hazard quotients were recalculated under the condition that the shrew diet is 100% annelids, rather than the 31.4% used in the ERA. The results of using this more conservative exposure parameter were that hazard quotients for mercury and lead in one soil area and lead in a second soil area would increase to just greater than 10. Although these hazard quotients would exceed 10, their contribution to overall risk would be relatively small and confidence in the conclusion that they pose a significant risk of harm to receptor populations would be low.

Exposure uncertainty is also associated with the removal, prior to sampling, of coarse organic material (leaf litter or detritus) overlaying sediment or soil. Analytical data reflect the concentration of COPCs in sediment, soil, and finer organic matter underlying the coarse organic matter at the surface. Therefore, analytical data may under or over estimate exposures for ecological receptors that inhabit or contact only the leaf litter or detritus at the surface of soil or sediment.

7.4.4.3 Toxicological Data. Toxicity values for soil invertebrates, surface water and sediment receptors, short-tailed shrews, and great blue heron were based on literature values. As for literature-based exposure parameter values, this is a source of uncertainty in the ERA. Contaminant toxicity is heavily influenced by bioavailability. Although bioavailability of different contaminants varies across the Site, the types of information available and the spatial coverage of data collection dictate that generalizations be made about parameters that may influence bioavailability (e.g., organic carbon content).

The sensitivity of on-site receptors to COPCs may also be different than the sensitivity of the species used in tests reported in the literature. For example, NOAA (1991) and Barrick and Beller (1989) toxicity values for sediment were derived based on the sensitivity of estuarine organisms, even though freshwater habitats were evaluated in the ERA. The sediment toxicity values for estuarine environments could over- or underestimate adverse effects to freshwater receptors, depending on how sensitivities to both environments differ. In addition, differences in species-specific senstitivities, or the age/ life stage of an organism could cause over- or under- estimation of risks when comparing literature test organisms to onsite conditions.

Assumptions about the equality of contaminant form between laboratory tests and site field conditions must be made in the absence of site-specific toxicological testing. This is a source of uncertainty because toxicity varies substantially with form of the toxicant in the environment. Thus, the actual toxicities of COPCs evaluated in this ERA could be higher or lower than the TRVs used. For example, the TRV for aquatic receptors was based on hexavalent chromium, which is generally considered more toxic than the trivalent form. In contrast, TRVs were based on trivalent chromium for the shrew and great blue heron and total chromium for soil and sediment invertebrates. The maximum exposure case hazard quotient for surface water chromium was greater than the chronic criterion for hexavalent chromium, but less than the chronic criterion for trivalent chromium. It is highly unlikely that all the chromium detected in surface water is present in the hexavalent state, the more toxic of the two valences. Therefore, the ERA result indicating that the maximum exposure case for chromium may pose a significant risk to aquatic receptors must be viewed with caution.

Results relating to risk from iron must also be viewed with caution. Table 7-42 indicates that the average exposure case to iron in surface soil poses a risk to shrews in the three soil areas. One reason why risks to shrews may be overestimated involves the endpoint from which the shrew TRV was derived. The TRV for iron exposure to shrews was based on the results of a subchronic LD_{50} test. Because a NOAEL was not available, there was a large uncertainty factor applied to the TRV (the TRV from the test was multiplied by 0.005). A second reason involves the form of iron. The test from which the shrew iron TRV was derived involved an oral dose of ferrous sulfate ($FeSO_4$). In soils not overlain by surface waters, iron in the environment is typically found in the +3 valence (ferric) state (USEPA, 1984). At the Site, much of the iron is likely rust (Fe_2O_3), which is less soluble that ferrous sulfate and therefore, likely to be less toxic.

Table 7-43 also indicates that the average exposure case to iron in the water column poses a risk to aquatic receptors in three of the five waterbodies on the Site. The basis of this result was the USEPA chronic AWQC for iron (USEPA, 1976). The criterion of 1 mg/l is based primarily on field observations (e.g., comparison of spatial presence of a species or community with iron concentrations in a watercourse). The toxicity of iron is heavily influenced by site-specific parameters such as alkalinity, pH, hardness, temperature, and the presence of ligands, which change the valence state and solubility. The effects of iron on aquatic receptors can be physical (e.g., egg smothering iron floc) or chemical. The level of risk with each of these types of effects would be dependent on the form of iron, the amount, and the exposed receptor community.

Additional sources of uncertainty involve the extrapolations of toxicity data across species or orders, and extrapolations from non-NOAEL endpoints to NOAELs. For such extrapolations, uncertainty factors were used to ensure that estimates of toxicity reference doses were conservative. Lastly, toxicity data were not available for some of the COPCs, resulting in a possible underestimation of risks at the Site.

7.4.4.4 Risk Estimation. One source of uncertainty in the risk characterization was calculating risks for certain COPCs based on arithmetic mean concentrations that were greater than maximum concentrations (as noted earlier, this occurred when high detection limits were incorporated in the exposure point calculations).

Another source of uncertainty was that HQs greater than 10 were defined as representing the potential for significant reductions in populations. In general, NOAELs were selected as TRVs. An HQ of 10 would mean an organism is exposed to a concentration that is an order of magnitude greater than a concentration known not to cause harm. While concentrations one order of magnitude higher than a NOAEL will likely impact organisms at the population level in many cases, populations of some organisms may not be severely impacted until concentrations are 100 or 1,000 times the NOAELs that were available in the literature.

7.4.4.5 Risk Contribution and Confidence. The contribution of individual analytes to risk and confidence in risk results are presented in Tables 7-47 through 7-53. Contribution to risk was determined by dividing each HQ by its associated HI. Based on the resulting percentage, each analyte was given a low, moderate, or high contribution rating. Confidence was qualitatively evaluated by considering what types of assumptions were used to derive the HQs. For example, if toxicity data on a surrogate animal were used to derive a TRV for a site receptor species (e.g., rat for shrew), a low confidence was assigned to the evaluation. Other criteria considered were detection limits, habitat for which benchmarks were derived, and the use of uncertainty factors. The intent of this exercise is provide the reader with insight regarding the importance of individual chemicals and chemical classes to risk within different areas of the Site. These tables will be used to assist risk managers in the next phase of Site evaluation.

7.5 SUMMARY AND CONCLUSIONS

The ecological risk assessment for the Site included an evaluation of adverse effects in terrestrial habitats and aquatic habitats. Adverse effects to soil invertebrates were evaluated using risk quotients, which represent a comparison of the surface soil exposure concentrations to chemical concentrations, below which adverse effects are not likely to occur to earthworms. Dietary exposures of SVOCs, pesticides, and inorganics to short-tailed shrew from the ingestion of earthworms, incidental surface soil, and surface water at the B&M Railroad Landfill, RSI Landfill, and B&M Locomotive Shop Disposal Areas (Areas A and B) were evaluated. These measurement endpoints were used to assess evidence of significant reduction in small mammal populations in terrestrial habitats.

Aquatic impacts were evaluated based on a comparison of sediment and surface water concentrations to values below which adverse effects are not expected to occur. In addition, results of the qualitative benthic macroinvertebrate survey were incorporated into the analysis. Dietary exposures of SVOCs, pesticides, PCBs, and inorganics to great blue heron from the ingestion of fish, sediment, and surface water at the West Middlesex Canal Group, Wetland 2 Group, East Middlesex Canal Group, Richardson Pond Group, and Content Brook Wetland Group were evaluated. These endpoints were used to evaluate evidence of significant reduction in migratory bird populations related to COPC levels at the Site.

The Contaminated Soil Area and the Old B&M Oil/Sludge Recycling Area were not quantitatively evaluated due to a lack of ecological receptors. Both areas contain little habitat cover and limited ground cover and earthworm populations are not expected to inhabit these areas. Without a prey base, such as earthworms, shrews would also not be expected to use these areas to forage. As a result, there were no complete exposure pathways for terrestrial receptors in these areas, thus they were not quantitatively evaluated.

It should be noted that COPCs associated with the Contaminated Soil Area and the Old B&M Oil/Sludge Recycling Area that could be transported to adjacent habitats (e.g., surface water and wetlands) were analyzed for in sediment and surface water in adjacent or downgradient areas. Thus, the COPCs associated with the Contaminated Soil Area were actually accounted for when assessing these adjacent and downgradient areas. It should be further noted that the ERA evaluated the potential for adverse effects to ecological receptors, based on current land-use conditions. If fate and transport mechanisms occur that may increase COPC concentrations in certain portions of the Site, the risks calculated in this ERA may not accurately reflect potential future adverse effects to ecological receptors.

Overall Terrestrial Summary. The results of the earthworm and short-tailed shrew analyses indicate potential for significant reductions in both soil invertebrate and small mammal populations at the B&M Railroad Landfill, and B&M Locomotive Shop Disposal Areas (Areas A and B). In general, inorganics and SVOCs (mostly PAHs) are the two contaminant groups of concern. For soil invertebrates, benzo(a)pyrene and chromium are the two COPCs of most concern in the terrestrial environments at the Site. COPCs for small mammals include antimony, cadmium, iron, and dibenzo(a,h)anthracene. The individual COPC analyses indicated that the B&M Railroad Landfill is the surface soil group with the greatest risks as it had the most HQs greater than 10 for soil invertebrates and small mammals combined. The weight of evidence from evaluation of risks at the B&M Locomotive Shop Disposal Areas (Areas A and B), although not as great as at the B&M Railroad Landfill, also indicated potential significant risk to terrestrial receptors populations including both invertebrates and mammals. Limited evidence was found for significant ecological risks to receptors inhabiting the RSI Landfill.

Overall Aquatic Summary. The evaluation of ecological risk in aquatic habitats identified minimal risks from surface water in the Middlesex Canal. Results of the surface water analysis for aquatic receptors indicate there are no COPCs with HQs or HIs greater than 10 in either of the primarily lotic water bodies in the Site (i.e., West Middlesex Canal Group and East Middlesex Canal Group). The results of the evaluation of potential risks to benthic receptors due to exposure to sediment COPCs in the Middlesex Canal indicate potential risks in West Middlesex Canal from exposure to SVOCs and also from exposure to copper, lead, PCBs, and pesticides on a limited spacial scale. No risk to migratory bird populations were identified from potential exposure to contaminants in either canal area (East or West Middlesex Canal). Overall, the weight of evidence suggested that risks to ecological receptor populations inhabiting the Middlesex Canal are not significant.

COPCs with surface water HQs greater than 10 occur in the three lentic areas, indicating the potential for significant reductions in aquatic populations during both high and low flow conditions as a result of the observed concentrations of numerous inorganics in the Wetland 2 Group (barium, iron, lead), Richardson Pond Group (barium, iron, and lead), and Content Brook Wetland Group (barium, aluminum, arsenic, iron, manganese and silver). All three of these surface water groups also had average and maximum HIs greater than 10 for inorganics. The highest HIs occurred in the Content Brook Wetland Group. Thus, aquatic populations are not only at risk from exposure to individual inorganics in each of these surface water bodies, but also from the combined effects of all inorganic COPCs.

Results of the sediment analysis for benthic receptors indicated that significant reductions in benthic populations could occur as a result of the observed concentrations of numerous PAHs and inorganics in the Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group. The concentrations of PAHs are the greatest concern to benthic populations within the Site. Support for this conclusion is provided by the average and maximum HIs for SVOCs which were the highest HIs in the Wetland 2 Group and Richardson Pond Group.

The macroinvertebrate surveys did not find any overt adverse effects that appear to be related to site contaminants and therefore do not add to the weight of evidence indicating that contaminant concentrations in surface water and sediment are significantly affecting the aquatic invertebrate populations in the Site. However, a more thorough quantitative analysis might expose subtle adverse effects due to contaminant concentrations that the qualitative survey could not.

Potential for significant reductions in migratory bird populations were indicated by the HQs greater than 10 in the Wetland 2 Group, Richardson Pond Group, and the Content Brook Wetland Group from exposures to inorganics (particularly mercury and zinc) and SVOCs (particularly dibenzo(a,h)anthracene).

SECTION 8.0
SUMMARY AND CONCLUSIONS

This section summarizes the findings and conclusions of the RI conducted at the 3rd operable unit of the Iron Horse Park Superfund Site, North Billerica, Massachusetts. The purpose of the RI was to assess contamination at the Site and evaluate human health and the environment risks related to the contamination. The geology, hydrogeology, nature and extent of contamination, fate and transport, human health risk, and ecological risk are summarized in the following text on a site-wide basis and by areas of concern.

8.1 OVERALL SITE-WIDE SUMMARY

The Site contains an active industrial complex (the Iron Horse Industrial Park), a rail yard, numerous manufacturing operations, open storage facilities, landfills, and lagoons, with a long history of activities that have resulted in contamination of soils, groundwater, surface water, sediment, and air at the Site. The current and future use of the Site is industrial. Surface water in the vicinity is designated for use as warm water fisheries and for contact recreation. Habitats of ecological value in the Site include forested and open field areas, surface water bodies, and open and forested wetlands.

The study area consists of 10 areas of concern including the B&M Railroad Landfill, the RSI Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, the Contaminated Soil Area, PCB Contamination, the Asbestos Landfill and Asbestos Lagoons (Asbestos Contamination), groundwater, and site-wide surface water and sediment.

The Site overlies low-yield and medium-yield aquifers. Although no water supply sources are located within the Site, community water supplies are located less than 1 mile east of Richardson

Pond and the Site is within the ½ mile Interim Wellhead Protection Zone for the Town of Tewksbury wells.

8.1.1 Geology

Bedrock underlying the Site is comprised of granite, schist, and diorite. Contoured bedrock surface elevations suggest the presence of a trough in the bedrock surface trending northeast and northwest across the Site. Bedrock fractures were found trending north-northeast and east-west.

The overburden primarily consists of glacial drift deposits including basal and ablation till and glacial outwash deposits. Basal till was found primarily on the southwestern portion of the Site, and ablation till was found primarily in the western and southern portion of the Site overlying basal till. Glacial outwash deposits were encountered throughout the Site. Peat deposits were encountered underlying fill materials near streams, ponds, and wetlands at the Site.

8.1.2 Hydrogeology

The overburden aquifer was subdivided into a shallow and deep aquifer to aid in determining the potential migration pathways. Groundwater is also contained and transmitted in weathered and fractured bedrock zones. Groundwater in both the overburden and bedrock aquifers generally enters the Site from the southwest and flows to the northeast. Similarly, surface water flows onto the Site from the south and flows to the northeast, where it converges with B&M Pond and associated wetlands. Based on seepage meter, staff gauge, and mini-piezometer results, the potential for groundwater to discharge to surface water was evident throughout most of the Site.

8.1.3 Nature and Extent of Contamination

More than 126 analytes including both organic compounds and metals in surface and subsurface soil, groundwater, surface water, and sediment were detected. The sources of contamination in the environmental media are primarily attributed to past industrial and railroad operations and associated disposal activities at the Iron Horse Industrial Park. However, on-going activities (e.g., vehicular activity, railroad operations, maintenance operations, etc) at the Site may continue to contribute certain types of contamination (e.g., PAHs, petroleum hydrocarbons, etc).

8.1.3.1 Surface and Subsurface Soils. Organic compounds and elevated metal concentrations were found in soil throughout the Site. The types of organic compounds that were characteristic of most areas of concern include pesticides, PAHs, and petroleum hydrocarbons. While pesticides were detected in similar concentrations in surface and subsurface soil, a greater number of pesticides were measured in subsurface soil. The numerous pesticides that were frequently detected were also found in background surface soils locations, as were some heavy metals (arsenic, copper, lead, manganese, vanadium, and zinc). Elevated concentrations were often found for some heavy metals (arsenic, manganese, and lead). PAHs and petroleum hydrocarbons were found throughout the Site, but were more predominant in areas of concern associated with railroad operations. Volatile organic compounds, phenolics, and PCBs were also frequently detected in subsurface soils. In comparison to other media, the occurrence of and concentrations of organic compounds and metals was more frequent in soil.

8.1.3.2 Groundwater. The types of organic compounds and metals detected in groundwater were similar to those measured in soil in each area of concern; however, the frequency of detection and concentrations measured were typically less than found in soils. Volatile organic compounds, primarily aromatic and chlorinated VOCs, were more frequently detected and were present in higher concentrations than SVOCs (PAHs, phenolics, and phthalates), pesticides, PCBs, and petroleum hydrocarbons. The types of organic compounds and the concentrations detected also were similar to those reported in the Phase 1A RI. The types of metals detected and concentrations found varied throughout the Site. Heavy metals likely to have originated from the areas of concern include arsenic, chromium, manganese, lead, and zinc. Field quality parameters indicated that geochemical conditions were similar between sampling rounds, and trends over time were not evident for organic compounds or metals.

8.1.3.3 Surface Water and Sediment. Site-wide surface water sampling locations were situated in different environmental settings across the Site, ranging from free-flowing channels in the Middlesex Canal and Content Brook, to wetland and swampy environments in Richardson Pond, to a small almost stagnant channel in the unnamed brook. The chemical characteristics of the surface water bodies varied because of the different environmental settings as well as nearby activities.

Organic compounds including VOCs, PAHs, phenolics, and pesticides as well as elevated metal concentrations were measured in surface water locations across the Site; however, the types of analytes and the concentrations detected were largely localized in extent. Concentrations and frequencies of detection tended to be higher in June than in September. The same types of organic compounds and metals detected in soils throughout the Site were found in surface water, but in comparatively lower concentrations.

As with surface water, organic compounds and elevated metal concentrations were detected at sediment locations across the Site. The organic compounds detected included PAHs, petroleum hydrocarbons, pesticides, and PCBs. These types of organic compounds were typically more prevalent in sediment than surface water. Like surface water, the chemical characteristics of sediments were localized. Organic compounds and elevated metal concentrations frequently occurred at locations which were near roads, railroad operations, the Shaffer Landfill, and areas of concern, particularly where overland runoff to surface water bodies was evident and flow rates were low.

8.1.4 Contaminant Fate and Transport

Potential migration pathways at the Site include transport through the unsaturated zone by percolation through wastes and contaminated soil and transport in the saturated zone by groundwater flow. Transport in surface water is most likely occurring by overland flow of surface water after contact with contaminated soils and wastes and suspension or resuspension of contaminated soils (sediment transport). Discharge of groundwater to surface water was evident throughout most of the Site. Although adsorption may be the dominant fate mechanism for most contaminants in the overburden, advection may dominate the fractured bedrock zones. There is evidence of potential NAPL at the Site. Although low concentrations of DNAPL-forming compounds in groundwater suggest that substantial pooled DNAPL is unlikely, residual forms of DNAPL may be present. Although no DNAPL was observed, LNAPL was found near the Old B&M Oil/Sludge Recycling Area.

8.1.4.1 Surface Soils. The high organic carbon content of surface soil acts to retain many types of organic compounds and metals, as indicated by the elevated concentrations of less mobile organic compounds such as PAHs, petroleum hydrocarbons, pesticides, and PCBs. Surface soils potentially migrate across the ground surface and eventually into nearby surface water bodies by overland flow. Although the overland flow runoff is more localized in most areas of concern, migration through erosion is largely in a north-northeast direction, consistent with site-wide drainage patterns. The surface water bodies and wetlands within the Site receive eroded soils by overflow runoff from the adjacent land mass, including the areas of concern.

8.1.4.2 Subsurface Soils. Since the areas of concern are not capped, precipitation percolates through the waste and contaminated surface and subsurface soil, dissolves contaminants, and transports them to groundwater. The high organic carbon content of subsurface soil acts to retain many types of organic compounds and metals, as indicated by the elevated concentrations of less mobile contaminants such as PAHs, petroleum hydrocarbons, PCBs, pesticides, and many metals. Leaching of VOCs is of greater concern than other organic compounds due to higher solubilities. Despite adsorption to soil, the likely source of groundwater contamination is subsurface soils.

8.1.4.3 Groundwater. Relatively low concentrations of VOCs, SVOCs, pesticides, PCBs and metals were measured in groundwater. More mobile organic compounds (chlorinated and aromatic VOCs and PAHs such as naphthalene) were found in higher concentrations. Although the concentrations detected and frequency of detection were not indicative of a substantial dissolved phase or delineated plumes, these types of contaminants have the potential to migrate further downgradient. A groundwater divide in the center of the Site may cause groundwater to flow to the north rather than northeast in the western portion of the Site.

Vertical hydraulic gradients are not large, but tend to be downward in the southwestern portion of the Site and upward in the north and northeast areas. Thus, contaminants found in groundwater, surface water, and sediment in the northeast portion of the Site could be a result of these gradients. Transport of contaminants in overburden groundwater is likely attenuated by adsorption to organic soils, dispersion, and degradation. However, fractured bedrock encountered throughout the Site may be a likely transport pathway for the mobile chlorinated VOCs that were detected in bedrock groundwater. In several areas, elevated metals concentrations in deep overburden and bedrock groundwater may be indicative of vertical migration and transport.

8.1.4.4 Site-Wide Surface Water. Inflow to surface water consists of groundwater discharge, surface water runoff via overland flow, and direct rainfall. Throughout the Site, groundwater discharges to surface water and contributes contaminants to surface water. Fewer organic compounds were detected in September than in June, which may reflect conditions of less groundwater discharge and less overland flow runoff in late summer and early fall. Adsorption to sediments is likely the primary attenuation mechanism for contaminants in surface water. No discernable migration trends in types of contaminants and concentrations were found, except in the Shaffer Wetlands where the most elevated levels of heavy metals were exhibited.

8.1.4.5 Site-Wide Sediment. Within the Site, primary transport pathways include overland flow runoff from the adjacent land mass, including the areas of concern, and resuspension in the flowing water bodies, especially the Middlesex Canal and the unnamed brook. Pesticides were frequently detected in sediment across the Site. PCBs are prevalent in the Middlesex Canal due to past discharges from the Johns-Mansville facility (currently on BNZ Materials property). The adsorption of contaminants is likely, since the sediments are high in organic carbon content. Since surface water velocities are not high within the Site, scouring and resuspension of sediments is not a dominant transport mechanism, but becomes more important during storm events that result in periods of high flow.

8.1.5 Human Health Risk Assessment

The baseline human health risk assessment was performed to evaluate the potential for adverse health effects to human populations who may come into contact with chemicals present within the Site. Exposures were evaluated for the following media: surface soil, sediment, surface water, and groundwater. For surface soil, Chemicals of Potential Concern (COPCs) were identified for each of the five areas of concern that were evaluated: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area, and Contaminated Soil Area. For sediment and surface water, COPCs were identified for each of three areas: West Middlesex Canal Area, Central Wetlands Area, and East Middlesex Canal and Wetlands Area. For groundwater, COPCs were identified for each of five areas of concern: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons.

Four media (surface soil, sediment, surface water, and groundwater) were evaluated quantitatively under various exposure scenarios. Possible human exposure to the selected COPCs was characterized through exposure pathways for current and future land use. It was assumed that future use of groundwater would be drinking water. Exposures to each of the site media were evaluated by area. Two sets of quantitative exposure estimates were prepared, corresponding to sets of exposure assumptions designated as central tendency and RME exposures.

The potential for adverse health effects was evaluated by comparing the calculated cancer risks to the target risk range of 10^{-6} to 10^{-4} and the calculated hazard indices to the target index of 1.0 as recommended by the EPA.

Site media for which all evaluated pathways are within or below the EPA's target risk range for carcinogens and noncarcinogens are:

- surface soil (for three of five areas evaluated)
- sediment (all three areas evaluated)

- surface water (all three areas evaluated)

Site media for which RME exposures for one or more pathways are above EPA's target risk range for carcinogens and/or noncarcinogens are:

- surface soil (two of five areas evaluated) under current and future land-use
- groundwater (all five areas evaluated) under future land-use

The contaminant responsible for excess risk in surface soil under current and future use is:

- lead (two of five areas evaluated)

The contaminants responsible for the majority of the groundwater risk under future land-use are:

- arsenic (five of five areas)
- manganese (five of five areas)

Other contaminants responsible for some excess risks, but not the majority of groundwater risks were:

- benzene (in RSI Landfill Area shallow overburden groundwater)
- beryllium (in Asbestos Lagoons Area deep overburden and bedrock groundwater)
- thallium (in RSI Landfill Area deep overburden groundwater)

8.1.6 Ecological Risk Assessment

Media of concern for ecological receptors included surface soil, surface water, and sediment. For surface soil, COPCs were identified for each of the three areas of concern: B&M Railroad Landfill, RSI Landfill, and the B&M Locomotive Shop Disposal Area. Two other areas of concern for surface soil (Contaminated Soil Area and the Old B&M Oil/Sludge Recycling Area), were evaluated qualitatively. For sediment and surface water, COPCs were identified for each of five areas: East Middlesex Canal, West Middlesex Canal, Richardson Pond, Wetland 2 Group (Central Wetlands), and Content Brook Wetlands.

The COPCs in surface soil include VOCs, SVOCs, pesticides, and metals with between 6 and 33 COPCs selected for each area. Although fewer in number, COPCs in surface water include: VOCs, SVOCs, pesticides, and metals. The largest numbers of COPCs were identified in the sediments (from 15 to 50 at each of the five areas of concern). Sediment COPCs include PCBs, SVOCs, VOCs, pesticides, and metals.

Complete exposure pathways for both terrestrial and aquatic habitats were identified, and receptor species were selected to evaluate potential exposure to COPCs. Adverse effects on soil invertebrates were evaluated using risk quotients, which represent a comparison of the surface soil exposure concentrations to chemical concentrations below which adverse effects are not likely to occur in earthworms. Dietary exposures to short-tailed shrews from the ingestion of earthworms, surface soil and dietary water were evaluated to assess evidence of the potential for significant reductions in small mammal populations.

Adverse effects on aquatic habitats were evaluated based on comparison of sediment and surface water concentrations to values below which adverse effects are not expected to occur. In addition, results of a benthic macroinvertebrate survey were incorporated into the analysis, and dietary exposures of migratory birds to COPCs were evaluated by assessing exposure of the great blue heron via ingestion of fish, sediment, and surface water within each of the five aquatic areas of concern.

Potential for significant reductions of soil invertebrate and/or small mammal populations was identified for the three areas evaluated quantitatively:

- B&M Railroad Landfill (SVOCs, cadmium, chromium, mercury, antimony and iron)

- B&M Locomotive Shop Disposal Areas (SVOCs, chromium, copper, antimony, and iron)
- RSI landfill (chromium)

The potential for significant ecological risk from exposure to soil contaminants was lower at the RSI Landfill, with chromium the only COPC identified with an average soil concentration indicative of the potential for reduction of invertebrate populations.

Evaluation of the Contaminated Soil Area and the Old B&M Oil/Sludge Recycling Area indicated lack of complete exposure pathways for terrestrial organisms. Both of these areas contain little natural habitat. Although there is potential for transport of soil contaminants to adjacent habitats (e.g., wetland areas), the lack of exposure pathways within these two areas limits the potential for significant ecological risk to receptor populations.

Potential ecological risk due to exposure of aquatic life to surface water contaminants was identified in the three primarily lentic habitats (wetlands/openwater):

- Wetland 2 Group (barium, iron, lead)
- Richardson Pond Wetlands (barium, iron, lead)
- Content Brook Wetlands (aluminum, arsenic, barium, iron, manganese, silver)

Potential ecological risk due to chronic exposure of aquatic life to sediment contaminants was identified in four of the surface water/sediment groups:

- West Middlesex Canal (SVOCs)
- Wetland 2 Group (SVOCs and copper)
- Richardson Pond Wetlands (SVOCs)
- Content Brook Wetlands (acenaphthene)

In addition, high concentrations of PCBs, copper, lead, and pesticides in some areas of West Middlesex canal indicated the potential for significant risk to sedentary aquatic receptors on a limited spacial scale.

Potential ecological risk due to exposure of migratory bird populations (great blue heron model) from the incidental ingestion of sediment or ingestion of fish was identified in the three primarily lentic habitats (wetlands/openwater):

- Wetland 2 Group (mercury, zinc and dibenzo(a,h)anthracene)
- Richardson Pond Wetlands (zinc and dibenzo(a,h)anthracene)
- Content Brook Wetlands (dibenzo(a,h)anthracene)

Potential risk from exposure to dibenzo(a,h)anthracene for the great blue heron through incidental ingestion of sediment may have been over-estimated in Wetland 2 Group and Richardson Pond wetlands because of high detection limits.

8.2 AREA-SPECIFIC SUMMARY

A discussion of the findings of the RI are summarized below for background locations and the specific areas of concern.

8.2.1 Background

Sample locations that were considered to represent site-wide background conditions were selected for surface soil, groundwater, surface water, and sediment. Various analytes were detected in background locations for each of the four media. In general, the analytical data are consistent with a lack of site-related contamination at the background locations. Maximum concentrations detected in background sampling are discussed below, with qualitative comparisons included for perspective on the magnitude of detected concentrations.

Background surface soils were found to contain metals and pesticides, but no VOCs, SVOCs, or PCBs. Lead in one of three background soil samples slightly exceeded the 90th percentile of a MADEP (1995) generic background soil data set. The other detected metals were below the MADEP 90th percentile for background. Various persistent chlorinated pesticides were consistently present in the parts-per-billion range in background samples. The pesticides are likely from past application of pesticides or atmospheric deposition. The lead and pesticide concentrations were below the MADEP reportable concentration for either of two soil reporting classifications (RCS-1 and RCS-2), as defined by the Massachusetts Contingency Plan. To the extent the concentrations reflect anthropogenic sources, the contamination may be considered minor.

Groundwater in background wells contained metals and concentrations of organic compounds near or below SQLs. Arsenic and lead concentrations exceeded statewide background concentrations compiled by MADEP (1994), but were slightly below MCLs and MADEP reportable concentrations for groundwater (RGW-1 and RGW-2), as defined by the MCP. Aluminum, iron, and manganese exceeded secondary MCLs, set for purposes other than protection of public health. Sodium exceeded drinking water guidelines. All of the other chemical analytes in groundwater were an order of magnitude lower than MCLs and MADEP reportable concentrations, where available. To the extent the concentrations reflect anthropogenic sources, the contamination may be considered minor.

Surface water contained metals and low levels of SVOCs and pesticides. No comparable state-wide or regional background statistics were located. No MCLs were exceeded, however, aluminum, iron, and manganese exceeded secondary MCLs and sodium exceeded drinking water guidelines. To the extent that surface water concentrations reflect anthropogenic sources, the contamination is probably minor.

Sediments contained metals and less than part-per-million concentrations of organic compounds. No comparable state-wide or regional background statistics were located. Maximum beryllium concentrations in sediment exceeded the concentration that would be reportable in soil. Otherwise, reportable concentrations for soil were not exceeded in background sediment. With the possible exception of some beryllium, any sediment contamination is probably minor.

8.2.2 B&M Railroad Landfill

This landfill, on the edge of a wetland, consists of up to 25 feet of landfilled materials overlying peat. Glacial outwash underlies fill or peat, and a weathered zone of granite bedrock was encountered at 50 feet below ground surface. Groundwater flow was observed to be to the east in the overburden and bedrock flow zones. Hydraulic conductivities suggest that the bedrock is less fractured in this portion of the Site. Horizontal hydraulic gradients are the lowest at the Site, and vertical gradients indicate that some groundwater flows upward from the bedrock to the shallow overburden. Groundwater discharge to surface water is likely from overburden and bedrock flow zones.

Similar types of organic compounds including VOCs, PAHs, phthalates, petroleum hydrocarbons, and pesticides were detected in surface and subsurface soils, with the highest concentrations occurring in subsurface soils. These contaminants were considerably less prevalent in groundwater. Heavy metal concentrations in surface and subsurface soils were higher than background soils. For soils, the southeastern half of the landfill was more contaminated with both organic compounds and metals. High concentrations of PCBs in subsurface soils suggest that PCB material, possibly oils, was disposed of. Aromatic VOCs, PAHs and petroleum hydrocarbons are indicative of petroleum-related products that probably include coal tar and creosote waste. In groundwater, wells located in the landfill exhibited the highest concentrations of contaminants, especially organic compounds. Aromatic and chlorinated VOCs, PAHs, pesticides, PCBs, and elevated metal concentrations were measured in groundwater, but concentrations were considerably lower than in soil. Although no NAPLs were found, oily sands were observed at several depths, and in conjunction with the types of organic compounds that were detected this suggests the evidence of NAPL. Degradation of TCE is evidenced by the presence of its potential byproducts, including several forms of DCE.

Since organic materials are prevalent in soils including PCBs, PAHs, and pesticides are not expected to migrate appreciably in the unsaturated zone, it is expected that the mobility of metals will be limited due to adsorption and other processes in soil. A migration pathway for VOCs in the unsaturated zone may be via vapor phase, since VOCs were detected more often at the top of the water table (in groundwater screening locations) than with depth below it.

With the exception of VOCs, most contaminants found in the saturated zone (pesticides, PCBs, PAHs, phthalates, and heavy metals) will not migrate significantly in the dissolved phase as evidenced by the groundwater quality in wells across from B&M Pond. The presence of PCBs and pesticides below the limits of the waste indicate that residual or pooled DNAPL may be present, although none was observed. Groundwater levels and analytical data indicate that groundwater is migrating vertically. Contaminants in the dissolved phase may migrate from the landfill to the B&M Pond to the east and the Middlesex Canal to the west as evidenced by downgradient contamination.

Measured vertical gradients indicates that groundwater discharges to the Middlesex Canal and B&M Pond. Contaminants are more prevalent in sediment than surface water due to attenuation processes. Contaminants detected in sediments were also found in upgradient reaches. PCBs in the Middlesex Canal may be a result of historic discharges from the stormwater drainage system at the former Johns-Mansville facility.

In the B&M Railroad Landfill, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within EPA risk limits of 10^{-6} to 10^{-4} for cancer risk and a hazard index of 1. Health risks from potential future ingestion of groundwater exceed EPA risk limits. Groundwater contaminants contributing to the risks above EPA risk limits, under central tendency and RME scenarios for one or more flow zones, were arsenic and manganese.

The results of the exposure pathways for the terrestrial environment indicated potential risk to soil invertebrate populations and small mammals due to exposures to metals (particularly antimony, chromium and mercury) and SVOCs (benzo(a)pyrene and dibenzo(a,h)anthracene) from surface soils at the B&M Railroad Landfill. Although risk was indicated from exposure to high concentrations of iron, there is a large degree of uncertainty with the risk calculation for iron due to the lack of toxicity data for shrews, and risk from exposure to iron may have been over-estimated.

8.2.3 RSI Landfill

This landfill, located in a topographically elevated portion of the Site, contains approximately 15 feet of fill material overlying glacial outwash and granite bedrock. Although the landfill is approximately 6 acres in size, the waste boundary delineated with geophysical surveys and soil borings was limited to a smaller area in the west-central portion of the landfill. Bedrock outcrops were observed to the south of the landfill.

Groundwater flow directions are to the northeast. Hydraulic conductivities suggest that bedrock is more highly fractured in this area of the Site. Horizontal hydraulic gradients vary only slightly with lithologies, and the vertical gradients are minimal. In the vicinity of this landfill, there is evidence that groundwater may be discharging to the unnamed brook at some locations, while in at least one location, the brook appeared to be losing water to groundwater.

Waste and fill present in the west-central portion of the landfill include organic compounds and heavy metals, detected in subsurface soils, and pesticides, PCBs, and phthalates that were also found in surface soils. Aromatic VOCs, pesticides, and PCBs were detected in groundwater at low concentrations. The detection of chlorinated VOCs in upgradient, as well as downgradient and vicinity wells, indicates that upgradient sources may be affecting groundwater quality. The presence of elevated vinyl chloride and dichlorinated VOCs directly downgradient of landfilled wastes and near the top of the water table (groundwater screening locations) are indicative of the degradation of wastes. It appears that the aromatic VOCs found in a groundwater cluster near the Johns-Manville Asbestos Landfill are not related to the RSI Landfill, since this well cluster is most likely hydrogeologically affected by the asbestos landfill.

Borings indicate that wastes were deposited above and below the water table. The absence of a low-permeability cover allows for contaminant transport from the unsaturated to the saturated zone. Similar to the B&M Railroad landfill, relatively elevated concentrations of PCBs, PAHs, and phthalates are found in the unsaturated zone. These compounds may be highly attenuated through adsorption in percolating water. Although these compounds may also migrate vertically in DNAPL form, no DNAPL was observed. Most metals are fairly immobile due to adsorption and low solubility; however, leaching is possible. Chlorinated VOCs (DCE and vinyl chloride) detected in groundwater screening samples indicate the partitioning of these compounds to the vapor phase. Therefore, vapor phase movement may be a prominent transport mechanism at the water table.

Most organic compounds with the exception of VOCs are not likely to migrate significantly in the dissolved phase. Pesticides, PAHs, phthalates and PCBs adsorb to organic matter in soils. However, due to the presence of more sandy soils, contaminant transport is of greater concern. Based on the direction of groundwater flow, contaminants in the dissolved phase will likely migrate toward the Middlesex Canal to the northeast and the unnamed brook to the southeast. Although vertical gradients are low, the presence of pesticides and PCBs in the deep overburden and bedrock groundwater indicates the potential for localized DNAPL pools; however, this was not confirmed during the field activities. The existence of shallow bedrock facilitates contaminant transport from the overburden to bedrock.

Pesticides and VOCs were detected in surface water and sediment in the unnamed brook. Overland flow could be the source of this contamination, although, upgradient sources also may be contributing. Measured vertical gradients and seepage velocities indicate discharge from groundwater to the unnamed brook.

In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within EPA risk limits of 10^{-6} to 10^{-4} for cancer risk and a hazard index of 1. Health risks from potential future ingestion of groundwater exceed EPA risk limits. Groundwater constituents contributing to the risks above EPA risk limits, under central tendency and RME scenarios for one or more flow zones, were arsenic, manganese, benzene, and thallium.

Chromium was the only COPC evaluated at the RSI Landfill indicating potential impact on earthworm populations, having an average HQ above 10. The only COPC with an HQ above 10 for the shrew analysis was iron. There is no indication of bioconcentration of chromium in the terrestrial food chain (Carey, 1982 in ATSDR 1987i), and the exposure analysis for shrews resulted in an HQ of for chromium of less than 1. The ecological risk to the terrestrial ecosystem at the RSI Landfill is restricted mainly to potential reductions in invertebrate soil populations resulting from exposure to chromium. Thus, without further direct evidence of reductions in invertebrate or mammal populations, the weight of evidence from exposure to soil contamination does not indicate significant ecological risk at the RSI Landfill.

8.2.4 B&M Locomotive Shop Disposal Areas (A and B)

Fill materials consist of metals, ash, coal and wood in area A and construction debris in Area B. Fill materials were underlain by outwash, ablation, till, basal till, and granite bedrock.

Groundwater flow appears to be towards the north-northeast in both areas. Vertical gradients indicate that the shallow overburden and bedrock are recharging the deep overburden, particularly in Area A, suggesting a preferential flow path. There is potential for groundwater discharge to surface water from both overburden and bedrock.

Heavy metals and organic compounds including pesticides, PAHs, and petroleum hydrocarbons were detected in surface and subsurface soils in both areas, where waste or fill material was found. A few organic compounds (including one VOC, a few pesticides, and one PCB Aroclor) and heavy metals were detected in groundwater in the downgradient and vicinity wells. The detection of organic compounds and some heavy metals in the upgradient cluster indicate that other sources may be present in the vicinity. Mercury and copper were the only detected metals that were not found in the upgradient wells.

The borings indicate that wastes exist above and below the water table. PAHs were found in the highest concentration, especially in subsurface soils, with lower concentrations of pesticides, PCBs, VOCs, and petroleum hydrocarbons. The absence of a low-permeability cover allows for contaminant transport from the unsaturated to the saturated zone. However, pesticides, PCBs and PAHs in percolating water may be highly attenuated through adsorption to organic matter in the soils.

Aromatic VOCs, PAHs, and petroleum hydrocarbons were notably absent in groundwater, although they were prevalent in subsurface soils. The absence of PAHs may be attributed to adsorption to soils. The absence of aromatic VOCs and petroleum hydrocarbons may be due to the placement of well screens below the water table. The potential for biodegradation of chlorinated compounds is evidenced by the existence of breakdown products of DCE and vinyl chloride near the water table. Based on the direction of groundwater flow, contaminants in the dissolved phase from both areas will migrate toward the northeast with groundwater discharge to the unnamed brook. Although vertical hydraulic gradients tend to be downward, there is no evidence that vertical migration of contaminants has occurred at this point.

Only pesticides were detected in surface water in the man-made canal. In contrast, PAHs, pesticides, phthalates, PCBs, and petroleum hydrocarbons were measured in sediments in the canal indicating that adsorption to sediments is occurring. Contaminants in sediments were similar to those measured in surface soils; therefore, overland flow runoff may be contributing to contaminant transport from these disposal areas. Vertical gradients indicate the potential for discharge from both the overburden and bedrock; however, low stream conductivities may limit discharge.

In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within EPA risk limits of 10^{-6} to 10^{-4} for cancer risk and a hazard index of 1. Indoor occupational exposures to lead in soil may result in excess blood lead levels in female workers. Health risks from potential future ingestion of groundwater exceed EPA risk limits. Groundwater constituents contributing to the risks above EPA risk limits, under central tendency and RME scenarios for one or more flow zones, were arsenic and manganese.

The weight of evidence from the analyses of exposures to surface soil at the B&M Locomotive Shop Disposal Areas (A and B) indicates potential ecological risk to terrestrial receptors, with potential effects on both invertebrate (benzo(a)pyrene, chromium and copper) and small mammal populations (antimony and iron).

8.2.5 Old B&M Oil/Sludge Recycling Area

Fill material found in this area includes black sand, ash, oily silt and clay, free product, bricks, wood, and foam rubber overlying glacial outwash, glacial till, and granite. Depth to bedrock ranges from 64 to 106 feet.

Groundwater flow directions are to the northeast and east in the shallow overburden, to the east in the deep overburden, and to the northeast in the bedrock. Vertical gradients indicate that deep overburden may be a preferential flow path. The influence of surface water bodies on groundwater flow is minimal in the area.

Two areas of oil/sludge, located in the northern and southern edges of the area, were found to extend beyond the Penn Culvert fence perimeter. The predominant types of organic compounds found were consistent with the oil/sludge reportedly disposed of in these areas. Contaminants detected in surface and subsurface soils consist primarily of PAHs, long-chain alkanes, and petroleum hydrocarbons. Numerous pesticides and PCBs were detected in the northern area, and heavy metals were measured in both areas. Although aromatic VOC, PAHs, and petroleum hydrocarbons were generally not present in groundwater, chlorinated VOCs and heavy metals were detected. Heavy metals, which were detected primarily in shallow overburden groundwater, include arsenic, chromium, cobalt, lead, mercury, nickel, and zinc. Petroleum hydrocarbons were measured in one well, and several inches of floating product was observed in one piezometer in the southern oil/sludge area.

Subsurface soils exhibited the highest concentration of contaminants including aromatic VOCs (BTEX compounds), PAHs, petroleum hydrocarbons, and elevated metal concentrations. Although some of the area is covered with asphalt, the absence of a low-permeability cover may facilitate contaminant transport to the saturated zone (especially VOCs). However, PAHs, pesticides, and metals will tend to adsorb to the organic matter (peat) prevalent in soils in this area. Based on observations of free product in the area and the occurrence of PAHs and petroleum hydrocarbons, LNAPL in residual or mobile form may be widespread. It was not detected in wells most likely because they are screened as much as 1 foot or more below the water table. The presence of high concentrations of PAHs may also indicate the presence of DNAPL.

Aromatic VOCs, PAHs, and petroleum hydrocarbons were notably absent in groundwater, although they were prevalent in subsurface soils. The absence of PAHs may be attributed to adsorption to soils. The absence of aromatic VOCs and petroleum hydrocarbons may be due to the placement of well screens below the water table. The potential for biodegradation of chlorinated VOCs is evidenced by the existence of breakdown products of DCE and vinyl chloride at near the water table. Based on the direction of groundwater flow, contaminants in the dissolved phase will likely migrate toward the northeast. Vertical hydraulic gradients tend to be downward from shallow overburden and upward from bedrock to deep overburden as evidenced by the presence of chlorinated VOCs in the deep overburden.

No surface water bodies are associated with this area.

In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within EPA risk limits of 10^{-6} to 10^{-4} for cancer risk and a hazard index of 1. Health risks from potential future ingestion of groundwater exceed EPA risk limits. Groundwater constituents contributing to the risks above EPA risk limits, under an RME scenario for one or more flow zones, were arsenic and manganese.

Evaluation of this area indicated lack of complete exposure pathways for terrestrial organisms. This area contains little natural habitat. Although there is potential for transport of soil contaminants to adjacent habitats, particularly wetland areas, the lack of exposure pathways limit the potential for significant risk to ecological receptors.

8.2.6 Contaminated Soil Area

Organic compounds measured in surface soils in localized areas within the area including PAHs, petroleum hydrocarbons, and pesticides. Lead and manganese were the heavy metals that were detected most often and in the highest concentrations. Cyanide was detected in a localized area along the southeastern boundary.

Soil contamination is likely the result of surface discharge from various work-related activities and is probably limited to surface soils. Evidence of free product spills included visual observation of oil-soaked or stained soils. Elevated levels of lead were detected throughout the area. Since lead is relatively insoluble and strongly adsorbed, significant migration in the unsaturated zone is not expected.

Pesticides, PAHs, VOCs, and heavy metals (especially lead) were measured in sediment at nearby water bodies. Overland flow runoff is the most likely transport pathway for this area. Based on drainage patterns to the northeast, this area could be contributing to contaminants in surface water and sediments in the Middlesex Canal, the unnamed brook, wetlands and ponds in the vicinity, as well as drainage ditches that lead to these water bodies.

In this area, potential exposures only to surface soil were evaluated. Health risks from surface soil are expected to be below or within EPA risk limits of 10^{-6} to 10^{-4} for cancer risk and a hazard index of 1. Estimated occupational blood lead levels were, however, elevated for this area due to the metals hot spot.

Evaluation of this area indicated lack of complete exposure pathways for terrestrial organisms. This area contains little natural habitat. Although there is potential for transport of soil contaminants to adjacent habitats, particularly wetland areas, the lack of exposure pathways limit the potential for significant risk to ecological receptors.

8.2.7 Asbestos Lagoons

Fill material consists of reworked sand and gravel and is underlain by peat, glacial outwash, and ablation till, and granite and schist.

Groundwater in the vicinity of the Asbestos Lagoons is divided with a component of flow to the northwest toward the Middlesex Canal and some flow to the northeast. Groundwater contours indicated the potential for mounding. The potential for discharge to surface water from groundwater is present; however, some data indicate that such discharge points may not occur.

Surface and subsurface soil samples were not collected during the RI. Groundwater contaminants included VOCs (primarily aromatics and chlorinated VOCs), PAHs, PCBs and pesticides. Several of the chlorinated VOCs (PCE, TCA and DCA) and heavy metals (arsenic, cobalt, lead, and zinc) were detected in all three flow zones. The types of contaminants found were similar to those detected in the 1980s during investigations related to the Johns-Manville stormwater drainage system. Detected heavy metals and organic compounds were primarily found in downgradient wells near the lagoons.

The limits of waste relative to the water table were not defined, since drilling was not conducted within the lagoons. The predominant types of compounds found in groundwater include pesticides and PAHs, which are likely to strongly adsorbed to soils. Concentrations of several metals were elevated, with calcium levels most elevated. This was to be expected due to the plasterboard materials that were disposed here.

Several metals, a few chlorinated VOCs, and PAHs were most prevalent in the deep overburden and bedrock groundwater. PCBs were detected in a shallow well adjacent to catch basins. Past wastewater discharges, stormwater drain leakages, and mounding caused by rainfall likely induced vertical migration of contaminants beneath the area. Low concentrations of pesticides in groundwater may be the result of percolating rainwater. Chlorinated VOCs are likely the most mobile contaminants. Groundwater flow is divided, with flow to the northwest toward Middlesex

Canal and to the northeast. Vertical gradients tend to be downward from shallow to deep overburden and upward from bedrock to shallow overburden at the downgradient wells.

Although there seems to be minimal potential for the Asbestos Lagoons to affect surface water and sediment transport, the most significant concern is the residual PCBs remaining in sediment at the Johns-Manville outfall locations in the Middlesex Canal. In the PCB Contamination Report (M&E, 1994b), it was concluded that sediments contaminated with PCBs and to a lesser extent SVOCs, VOCs, PAH and metals were being transported downstream within the Middlesex Canal.

In this area, potential exposures only to groundwater were evaluated. Health risks from potential future ingestion of groundwater exceed EPA risk limits of 10^{-6} to 10^{-4} for cancer risk and a hazard index of 1. Groundwater constituents contributing to the risks above EPA risk limits, under central tendency and RME scenarios for one or more flow zones, were arsenic, beryllium, and manganese.

8.2.8 Site-Wide Surface Water

Several VOCs were detected in at some surface water locations during both sampling rounds. BTEX compounds were found at several locations in Richardson Pond. Chlorinated VOCs including TCA, DCE, PCE, and TCE were detected in several surface water locations. In addition to aromatic and chlorinated VOCs, several VOCs that are gases under normal conditions including chloromethane were found in low concentrations. Generally, contaminants including PAHs, pesticides, and metals were detected more often and in higher concentrations in June compared to September indicating variability over time. In the vicinity of Shaffer Landfill, specific conductance and heavy metals concentration were elevated.

Discharge of groundwater from the RSI and B&M Railroad Landfills may be the source of chlorinated VOCs found in the RSI wetland, the Middlesex Canal near the B&M Pond, and the unnamed brook. An outfall discharge pipe in the sedimentation pond on the unnamed brook may also be the source of VOCs detected at that location.

Human health risks associated with potential exposures to surface water are expected to be within or below EPA risk limits.

The evaluation of ecological risk in aquatic habitats identified minimal risks from surface water in the Middlesex Canal. Potential ecological risk due to exposure of aquatic life to inorganic contaminants in surface water was identified in the three primarily lentic habitats (wetlands/open water) including: Wetland 2 Group (barium, iron, lead), Richardson Pond Wetlands (barium, iron, lead) and Content Brook Wetlands (aluminum, arsenic, barium, manganese, silver). In addition ingestion of surface water did not contribute a major component for the evaluation of exposure of migratory birds for any of the surface water data groupings.

8.2.9 Site-Wide Sediment

Similar to surface water, the frequency of detection and concentration of contaminants including aromatic and chlorinated VOCs, PAHs, pesticides, and PCBs were generally greater in June than September. Heavy metals were found in similar concentrations during both sampling rounds. Aromatic compounds detected include BTEX and chlorobenzene. Chlorinated VOCs were measured at locations where aromatic VOCs were found, and petroleum hydrocarbons were detected in higher concentrations where PAHs, were found. PCBs were detected at more than half the locations in June, with the highest PCB concentration measured at the base of a discharge pipe from the Johns-Manville (currently BNZ Materials) property. In addition, the detection of PAHs and elevated lead concentrations in the southwest corner of Richardson Pond suggests the probable transport of contaminants by overland flow runoff from Shaffer Landfill, Pond Street, and the MBTA railway tracks.

Human health risks associated with potential exposures to sediment are expected to be within or below EPA risk limits.

The results of the evaluation of potential risks to aquatic receptors due to exposure to sediment contaminants in the Middlesex Canal indicate potential risk from exposure to inorganic analytes (primarily copper and lead) and SVOCs in sediments in the West Middlesex Canal. In addition, high concentrations of PCBs in some areas of West Middlesex canal indicated significant risk to sedentary aquatic receptors. However, no risk to migratory bird populations from potential exposure to contaminants in either canal (East or West Middlesex Canal) were identified.

Greater ecological risks in aquatic habitats were identified for the three primarily lentic (standing water) habitats. Each of these areas (Wetland 2 Group, Richardson Pond Group and Content Brook Group) include large wetland complexes and depositional environments. Ecological risk due to chronic exposure of aquatic life to sediment contaminants was identified in these wetland habitats as follows: Wetland 2 Group (SVOCs and copper), Richardson Pond Wetlands (SVOCs and copper) and Content Brook Wetlands (acenaphthene and arsenic). Potential ecological risk due to exposure of migratory bird populations (great blue heron model) from the incidental ingestion of sediment or ingestion of fish was identified in the three primarily lentic habitats: Wetland 2 Group (mercury, zinc and dibenzo(a,h)anthracene), Richardson Pond Wetlands (zinc and dibenzo(a,h)anthracene) and Content Brook Wetlands (dibenzo(a,h)anthracene). Potential risk from exposure to dibenzo(a,h)anthracene for the great blue hereon through incidental ingestion of sediments may have been over-estimated in Wetland 2 Group and Richardson Pond wetlands because of high detection limits.

8.3 CONCLUSIONS

The RI indicated that 1) contaminants were detected in all media including groundwater, surface and subsurface soil, surface water, and sediment; 2) contaminant transport mechanisms were influenced by groundwater flow, geologic features, and groundwater/surface water interaction; and 3) increased human health and ecological risks were evident. Detailed conclusions are presented below.

- aromatic and chlorinated VOCs, petroleum hydrocarbons, pesticides, PCBs, and PAHs were the most prevalent organic compounds detected throughout the Site. Elevated metal concentrations were evident in various media.

- Organic compounds and elevated metal concentrations detected in surface water and sediment occurred at localized areas.

- Differences between sampling rounds were not evident in groundwater, however in surface water and sediment, higher concentration of contaminants were detected in the June than in September.

- Fractured and weathered bedrock found throughout the Site impacts localized flow and contaminant transport in bedrock.

- Vertical gradients between the overburden and bedrock flow systems and surface water indicate discharge of groundwater to the Middlesex Canal, B&M Pond, and the unnamed brook.

- The groundwater and surface water interaction as well as surface runoff play a major role in the fate and transport of contaminants.

- Although the presence of LNAPL and DNAPL was not confirmed in any areas of concern, with the exception of the Old B&M Oil/Sludge Recycling Area, the types of contaminants detected and the depths indicate that these may exist in isolated areas of the Site.
- Elevated blood lead levels may result from indoor occupational exposures of female workers to Site soils in the B&M Locomotive Shop Disposal Area and the Contaminated Soil Area, particularly the metals hot spot.

- Excess lifetime cancer risk for human receptors may exceed EPA's target range for future potential residential use of groundwater at the Site.

- Noncarcinogenic risk for human receptors may exceed EPA's target hazard index of 1.0 for future potential residential use of groundwater at the Site.

- Modeled exposures to surface water and sediment are not expected to be associated with health risks exceeding EPA risk limits.

- Ecological risk from exposure of soil invertebrates to metals and SVOCs in surface soils was identified at B&M Railroad Landfill, the RSI Landfill and the B&M Locomotive Shop Disposal Areas (A and B). Metals contributing the majority of risk included cadmium, chromium, mercury, copper, iron and antimony.

- Maximum concentrations of PCBs (Aroclor 1248) in West Middlesex Canal and the Wetlands 2 Group (Central Wetlands) exceeded the aquatic life criteria for sediments, indicating risk for sedentary benthic organisms.

- Surface water concentrations of metals exceeded aquatic life criteria in the three primarily lentic habitats (wetlands/open water) including: Wetland 2 Group (barium, iron, lead), Richardson Pond Wetlands (barium, iron, lead) and Content Brook Wetlands (aluminum, arsenic, barium, manganese, silver).

- Ecological risk due to chronic exposure of aquatic life to sediment contaminants was identified in wetlands habitats due to exposure to metals and SVOCs. Migratory bird populations feeding at the Site are at risk from the incidental ingestion of sediment or ingestion of fish in the three primarily lentic habitats: Wetland 2 Group (mercury, zinc and dibenzo(a,h)anthracene), Richardson Pond Wetlands (zinc and dibenzo(a,h)anthracene) and Content Brook Wetlands (dibenzo(a,h)anthracene).

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North Billerica, Massachusetts

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TABLE 1-1. CHRONOLOGY: IRON HORSE PARK SITE, 3rd OPERABLE UNIT*

Year	Activities within the Site Boundaries
1911	B&M Railroad purchased 553 acres of land that now makes up the Iron Horse Park site.
1913	B&M Railroad began operations at the Site.
1924	B&M Railroad began operating a combined sewage and drainage system for the Iron Horse Industrial Park.
1938	Oil and sludge recycling activities began on B&M property later owned by the Omega Trust and currently owned by Penn Culvert.
1944	B&M Corporation sold approximately 70 acres of land to Johns-Manville Products Corporation, which manufactured structural insulating board. Two unlined lagoons, located on the newly purchased land, were used to dispose of asbestos sludge waste. In addition, approximately 15 acres of land was leased from B&M for use as a landfill for asbestos waste.
1961	Johns-Manville sold the western portion of its land to General Latex and Chemical Corporation.
1961	Aerial photographs indicate that wetland areas east of the railyard, on the north side of the Middlesex Canal, were being filled by B&M Railroad.
1961	B&M Railroad sold, to Omega Trust, a 23-acre parcel of land on which oil and sludge recycling took place.
1962	B&M Railroad sold approximately 1.2 acres of land and an existing building to Wood Fabricators, Inc.
1966	B&M Corporation sold an additional 0.67 acres of land to Wood Fabricators, Inc.
1966	B&M Corporation sold approximately 106 acres of land to Phillip Shaffer as Trustee of Gray Pond Realty Trust. Prior to 1966, this land was used for open burning.
1968	Billerica Board of Health ordered that open burning practices cease on the land owned by Phillip Shaffer. The land was then used as a landfill, accepting both commercial and residential waste materials. This area is known as the Shaffer or Pond Street Landfill.
1969	Aerial photographs indicate significant expansion of existing landfill areas located in the eastern portion of Iron Horse Park. These areas include B&M land being used by Johns-Manville for disposal of asbestos waste, the B&M landfill north of the canal, and the Shaffer Landfill.
1973	Omega Trust sold the oil and sludge recycling area to Penn Culvert Company.
1976	Aerial photographs indicate that the expansion of the existing landfills has slowed or even halted. Vegetation has returned to parts of each landfill.

TABLE 1-1 (Continued). CHRONOLOGY: IRON HORSE PARK SITE, 3rd OPERABLE UNIT*

Year	Activities within the Site Boundaries
1976	B&M Corporation sold approximately 150 acres of primarily developed land to the MBTA to operate passenger rail service, including land along the northern portion of the Shaffer landfill.
1979	Aerial photographs indicate that the old B&M oil & sludge recycling area has been cleared, leveled, and filled. The area is currently a partially paved lot used as a storage area.
1984	Iron Horse Park site was placed on the National Priorities List as a result of MADEP investigations and a site investigation report.
1984	A lawsuit was filed against Phillip Shaffer by the MADEP for environmental violations.
1984	The Johns-Manville asbestos landfill was capped during an immediate removal action under CERCLA performed by the EPA.
1986	In compliance with a state court order, the Shaffer Landfill ceased operations in April 1986.

* Source: CDM (1989b)

TABLE 1-2. SUMMARY OF SOIL SAMPLES FROM THE OLD B&M OIL/SLUDGE RECYCLING AREA ON THE PENN CULVERT PROPERTY *

Sample Identification	Sample Depth (feet)	Total Volatiles (ppb)	Total PAHs (ppb)	Arsenic (ppm)	Cadmium (ppm)	Chromium (ppm)	Lead (ppm)
NUS Samples Collected 12/83							
IHP-S67	2	<1.0	<420	6	1.9	35	23,900
IHP-S68	2	<1.1	<450	8.2	1.7	20	26,900
IHP-S69	2	4	<1,100	19	1.9	28	19,000
CDM Samples Collected 3/86							
SB-27-052	0-1	<5.0	491	4.8	ND	12	8.6
SB-27-053	3-4	<5.0	<0.6	5.8	ND	13	118
SB-32-047	0-0.5	190	9,600	4.4	ND	16	22
SB-32-048	1.5-2	<1.0	2,850	ND	ND	ND	26
PZ-11-025	0-2	<1.0	<1.0	8.9	ND	9	11
PZ-11A-026	5-7	<1.0	<12.0	ND	ND	ND	362
PZ-12-027	0-2	<1.0	<13.0	12.7	ND	13	4,760
PZ-12A-028	4-6	<1.0	7,400	16.9	3	19	2,220
PZ-12A-029 (Dup. of 12A-028)	4-6	47	7,300	12.4	2	15	2,930

* Source: CDM (1989a)
ND - Not Detected

TABLE 1-3. LEAD LEVELS IN SITE SOILS THAT EXCEED TYPICAL BACKGROUND LEVELS FOUND IN NEW ENGLAND SOILS*

Sample Location	Sample Identification	Sample Depth (feet)	Lead Concentration (ppm)
NUS Samples Collected 12/83			
Penn Culvert	IHP-S67	2	23,900
Penn Culvert	IHP-S68	2	26,900
Penn Culvert	IHP-S69	2	19,900
CDM Samples Collected 11/85 and 3/86			
Johns-Manville	SB-22-030	0-1	315
Johns-Manville	SB-26-039	0-1	310
B&M	SB-28-054	0-1	76,600
B&M	SB-28-055	3-4	527
B&M	SB-30-043	0-1	539
B&M	PZ-08-017	0-2	2,890
B&M	PZ-09-020	0-2	59,200
B&M	PZ-09A-021	4.5-6.5	4,610
B&M	PZ-18-042	0-2	2,940
Penn Culvert	PZ-11A-026	5-7	362
Penn Culvert	PZ-12-027	0-2	4,760
Penn Culvert	PZ-12A-028	4-6	2,220
Penn Culvert	PZ-12A-029	4-6	2,930

* Source: CDM (1989a)

TABLE 2-1. CHRONOLOGY OF RI FIELD INVESTIGATION ACTIVITIES

Date	Activities Performed
May to June, 1993	Site Mobilization Including Construction of Field Support and Drum Storage Areas
May 10 and 12, July 15, 1993	Wildlife Surveys
May 27 and 28, 1993	Surface Water and Sediment Sampling Location Reconnaissance
June 9 to 22, 1993	Surface Water and Sediment Sampling–High Flow Round
July 6 to 8, 1993	Grid System Establishment
July 13 to 16, 1993	Existing Well and Piezometer Inventory
July 15 and 16, 1993	Staff Gauge Installation
July 15, 1993 and November 8, 1994	Habitat Delineation and Wetland Inspection
July 21 to August 5, 1993	Geophysical Surveys
July 22 to September 5, 1993	Surface Soil Sampling
August 16 to 24, 1993	Test Pit Excavation and Sampling
August 24 to September 3, 1993	Soil Borings Advancement and Sampling
September 13, 1993	Water–Level Measurements–Round 1
September 14 to 22, 1993	Surface Water and Sediment Sampling–Low Flow Round
September 27 to October 8, 1993	Groundwater Screening and Analysis by Gas Chromatograph
October 6 and 7, 1993	Benthic Reconnaissance
October 25 and December 12, 1993	Walkover and Inspection of Johns–Manville Asbestos Landfill
December 8, 1993	Water–Level Measurements–Round 2
November 29 to December 7, 1994	Piezometer Installation
December 7 and 8, 1994	Additonal Geophysical Surveys
December 14, 1994	Water–Level Measurements–Round 3
January 3 to March 1, 1995	Monitoring Well Installation
February 8 to March 2, 1995	Monitoring Well and Piezometer Development
March 28 to April 10, 1995	Groundwater Sampling of Monitoring Wells–Round 1
March 30, 1995	Seepage Meter Installation
April 12, 1995	Water–Level and Seepage Meter Measurements–Round 4
July 17 to 28, 1995	Groundwater Sampling of Monitoring Wells–Round 2
August 1, 1995	Water–Level and Seepage Meter Measurements–Round 5
August 7 to 11, 1995	Aquifer Testing
September to October, 1995	Demobilization of Field–Support Area
December, 1995	Disposal of Drummed Wastes

TABLE 2-2. SUMMARY OF RI FIELD INVESTIGATION ACTIVITIES BY AREA

Area	Activity	
B&M Railroad Landfill	Establishment of Grid System Geophysical Surveys (EM and GPR) Test Pit Excavation and Sampling Soil Boring Advacement and Sampling Surface Soil Sampling	Groundwater Screening for Volatile Organics Piezometer Installation Monitoring Well Installation Groundwater Sampling Aquifer Testing
RSI Landfill	Establishment of Grid System Geophysical Surveys (EM and GPR) Test Pit Excavation and Sampling Soil Boring Advacement and Sampling Surface Soil Sampling	Groundwater Screening for Volatile Organics Piezometer Installation Monitoring Well Installation Groundwater Sampling Aquifer Testing
B&M Locomotive Shop Disposal Areas (A and B)	Establishment of Grid System Geophysical Surveys (EM and GPR) Test Pit Excavation and Sampling Soil Boring Advancement and Sampling Surface Soil Sampling	Groundwater Screening for Volatile Organics Piezometer Installation Monitoring Well Installation Groundwater Sampling Aquifer Testing
Old B&M Oil/Sludge Recycling Area	Establishment of Grid System Geophysical Surveys (EM and GPR) Test Pit Excavation and Sampling Soil Boring Advancement and Sampling Surface Soil Sampling	Groundwater Screening for Volatile Organics Piezometer Installation Monitoring Well Installation Groundwater Sampling Aquifer Testing
Contaminated Soil Area	Surface Soil Sampling	
Asbestos Lagoons	Establishment of Grid System Sediment Sampling Groundwater Screening for Volatile Organics Piezometer Installation	Monitoring Well Installation Groundwater Sampling Aquifer Testing
Asbestos Landfill	Walkover and Inspection	
Site-Wide	Existing Well and Piezometer Inventory Groundwater and Surface Water Elevation Measurements Wildlife Surveys Wetland Habitat Delineation/Inspection	Ecological Resources Investigation Surface Water and Sediment Sampling Seepage Meter/Staff Gauge Installation

TABLE 2-3. SUMMARY OF M&E'S RI FIELD INVESTIGATION

Activity	Purpose	Action
Site Reconnaissance		
Site Mobilization	Establish a field support and drum storage areas	Oversaw placement of gravel and installation of fences around each area; delivery and setup of the storage, office and decontamination trailers; and installation of telephone, water, and electricity services to site support area
Ecological Characterization	Assess use of site biological resources; identify overt effects of contamination and ecological pathways; confirm the location and extent of ecological resources	Mapped extent of wetlands and habitat types; performed reconnaissance of animal life
Establishment of Grid System	Set up points of reference for future field activities	Established a reference grid, parallel to magnetic north using 100-foot on centers, in five areas of concern
Evaluation of Asbestos Landfill Cap	Inspect the integrity and current conditions of the landfill cap	Visually inspected existing topsoil, vegetative cover, and surface water drainage patterns
Hydrogeological Assessment		
Existing Well Inventory	Determine usability of existing wells and piezometers for characterization of groundwater contamination and groundwater flow direction	Conducted a reconnaissance to locate and evaluate condition of existing wells and piezometers
Surface Water Evaluation Measurements	Determine the head differential between groundwater and surface water near potential source areas	Installed staff gauges in surface water bodies and measured water levels concurrently with groundwater levels
Groundwater Evaluation Measurements	Establish site-wide synoptic groundwater levels for shallow overburden, deep overburden, and bedrock	Measured water levels in all monitoring wells within a single 24-hour period

TABLE 2-3 (Continued). SUMMARY OF M&E'S RI FIELD INVESTIGATION

Activity	Purpose	Action
Surface Geophysical Surveys		
Electromagnetic (EM)	Determine extent of fill in disposal/landfilled areas; determine location of buried objects or drums that would indicate potential source areas; determine horizontal extent of oil and sludge in the Old B&M Oil/Sludge Recycling Area	Conducted surveys in designated areas using 25-foot-grid spacing
Ground Penetrating Radar (GPR)	Verify extent of fill in disposal/landfilled areas; verify EM results	Conducted GPR transects as needed at 50- to 100-foot spacings
Test Pit Excavation	Investigate geophysical anomalies and determine horizontal and vertical extent of fill material	Excavated test pits in areas where geophysical anomalies were detected
Soil Borings	Assess the potential ability of contaminants to migrate through the overburden soils	Collected and analyzed selected soils for total combustible organics (TCO), grain size, permeability, and porosity
Groundwater Screening	Evaluate volatile organic contamination in shallow groundwater downgradient of potential source areas in the areas of concern	Collected groundwater using Geoprobe sampling apparatus to a maximum depth of 12 feet; performed headspace screening on groundwater samples for 11 volatile organic compounds; measured pH, specific conductance, and temperature if sufficient sample volume was available
Piezometer Installation	Determine the depth to water in the five study areas; characterize groundwater flow directions	Installed a total of 18 shallow wells in the 5 areas with 3 wells in each area
Monitoring Well Installation	Characterize potential groundwater contamination and groundwater flow direction	Installed 43 monitoring wells in 13 clusters of 3, 1 cluster of 2, and 2 single wells. Each triple cluster was composed of a shallow and deep overburden well and a bedrock well

TABLE 2-3 (Continued). SUMMARY OF M&E'S RI FIELD INVESTIGATION

Activity	Purpose	Action
Environmental Sampling		
Soil Sampling	Investigate the potential extent of contamination in the overburden soils	Collected 79 surface soil, 24 test pit soil, and 91 soil boring samples
Surface Water Sampling	Investigate the potential extent of site contamination in surface-water bodies	Collected samples at 46 locations across the study area
Sediment Sampling	Characterize and define sources areas and investigate the extent of contamination	Collected samples from 51 locations across the study area
Groundwater Sampling	Determine background concentrations of groundwater	Collected and analyzed groundwater samples upgradient of the site
	Evaluate the type and extent of contamination in groundwater to evaluate human health risks	Collected and analyzed groundwater upgradient and downgradient of source areas and compared results to background levels
	Assess potential seasonal fluctuations in contaminant concentrations	Collect two rounds of groundwater samples in different seasons

TABLE 2-4. EXISTING WELL AND PIEZOMETER INVENTORY (1)

Well ID Number (2)	Formation Screened	Well ID Mark Present	Well Secured On Arrival	Well Plumb Level	PVC Cap Present	Condition of PVC	Condition of Outer Casing	Condition of Concrete Pad	Survey Mark Present	Depth to Bottom Inst. (3) (ft bgs)	Depth to Bottom Meas.(4) (ft bgs)	Depth to Water (4) (ft TOC)	PID Reading (ppm)	Additional Comments
Monitoring Wells – "OW" Series														
OW-01	Bedrock	yes	yes	yes	no	accep	accep	accep	no	55.5	51.5	4	0	Possible silting in well
OW-02	Deep OB	yes	yes	yes	no	accep	accep	pfh	no	25.58	25.2	4	0	
OW-03	Shallow OB	yes	yes	yes	no	accep	accep	pfh	no	13	13	4	0	
OW-04	Deep OB	illeg	yes	yes	no	accep	accep	pfh	no	25.25	25.1	18.5	0	
OW-05	Bedrock	no	yes	yes	no	accep	accep	accep	no	33	31.8	13	15	Slight frost heaving
OW-06	Deep OB	yes	yes	yes	no	accep	accep	accep	yes	9.5	10.4	dry	100	Well is dry
OW-07	Deep OB	yes	yes	yes	no	accep	accep	accep	no	40.25	40.1	8	0	
OW-08	Shallow OB	yes	yes	yes	no	accep	accep	accep	no	20.4	19.5	7.5	0	
OW-09	Bedrock	yes	yes	yes	no	accep	accep	accep	no	84.5	84.5	7	0	
OW-10	Deep OB	yes	yes	yes	no	accep	accep	accep	no	65	60	7	0	
OW-11	Shallow OB	yes	yes	yes	no	accep	accep	accep	no	40	40	7	0	
OW-12	Shallow OB	yes	no	yes	no	accep	accep	accep	no	20	20	7	0	
OW-13	Deep OB	yes	yes	yes	no	accep	accep	accep	no	48	48.2	11.5	0	
OW-14	Shallow OB	yes	yes	yes	no	accep	accep	accep	no	22.8	15	11.5	0	Organic material in well
OW-15	Deep OB	yes	yes	yes	no	cracked	accep	accep	no	39.33	39.2	8	0	
OW-16	Shallow OB	yes	yes	yes	no	accep	accep	accep	no	18.5	18.40	8.5	0	
OW-17	Bedrock	yes	no	yes	no	accep	accep	accep	no	70	70	5.5	0	
OW-18	Deep OB	yes	no	yes	no	accep	accep	accep	no	39.33	39.3	5	0	
OW-19	Shallow OB	yes	no	yes	no	accep	accep	accep	no	21.33	21.2	4.5	0	Casing is open
OW-20	Deep OB	yes	yes	yes	no	cracked	accep	accep	no	43.5	37.5	7	0	Poss. silted in well
OW-21	Shallow OB	yes	yes	yes	no	accep	accep	accep	no	18	18	7	0	
OW-22	Bedrock	yes	yes	yes	no	accep	pfh	pfh	no	41.9	40.5	7.5	0	
OW-23	Deep OB	yes	yes	yes	no	accep	pfh	pfh	no	16	14.9	7.5	0	
OW-24	Deep OB	yes	yes	yes	no	accep	accep	nv	no	24.5	24.8	11.5	0	PVC 1.5 ft below casing
OW-25	Deep OB	yes	yes	yes	no	accep	accep	nv	no	60	58.8	6.5	0	
OW-26	Shallow OB	yes	yes	yes	no	accep	accep	nv	no	40	39.5	6.5	0	
OW-27	Shallow OB	yes	yes	yes	no	accep	accep	nv	no	20	20.4	6.5	0	

TABLE 2-4 (Continued). EXISTING WELL AND PIEZOMETER INVENTORY (1)

Well ID Number (2)	Formation Screened	Well ID Mark Present	Well Secured On Arrival	Well Plumb Level	PVC Cap Present	Condition of			Survey Mark Present	Depth to Bottom		Depth to Water (4) (ft TOC)	PID Reading (ppm)	Additional Comments
						PVC	Outer Casing	Concrete Pad		Inst.(3) (ft bgs)	Meas. (4) (ft bgs)			
Monitoring Well – "OW" Series (Continued)														
OW-28	Bedrock	}		---	---	---	---	---	---	93.25	---	---	---	
OW-29	Deep OB	} not accessable		---	---	---	---	---	---	56.25	---	---	---	
OW-30	Shallow OB	} to inventory		---	---	---	---	---	---	29.5	---	---	---	
OW-31	Shallow OB	}		---	---	---	---	---	---	15.33	---	---	---	
OW-32	Deep OB	yes	yes	yes	no	accep	accep	accep	yes	40	40	5	50	
OW-33	Shallow OB	yes	no	yes	no	accep	accep	pfh	yes	20	20	5	0	
OW-34	Bedrock	yes	yes	yes	no	accep	accep	accep	no	67	67.5	5	0	Couldn't lock
OW-35	Deep OB	yes	yes	yes	no	accep	accep	accep	no	37.25	37.2	5	0	
OW-36	Shallow OB	yes	yes	yes	no	accep	dmgd	accep	no	15	15.2	5	0	
OW-37	Bedrock	yes	yes	yes	no	accep	accep	nv	no	59.33	59.5	5	0	
OW-38	Deep OB	yes	yes	no	no	accep	accep	nv	no	29.7	29.5	5	0	
OW-39	Deep OB	yes	no	yes	no	accep	accep	crack	no	24	24.4	4.5	0	
OW-40	Shallow OB	yes	no	yes	no	accep	dented	crack	no	8.9	7.1	4	0	Damaged from timbers
OW-41	Deep OB	yes	yes	yes	no	accep	accep		no	53	52.5	6.0	16	
OW-42	Shallow OB	yes	yes	yes	no	accep	accep	accep	no	31	32	7	500	
OW-43	Shallow OB	yes	yes	yes	no	accep	accep	accep	no	15	15.4	6	500	
OW-44	Bedrock	yes	yes	yes	no	accep	accep	accep	no	66.5	57	5	25	
OW-45	Deep OB	yes	yes	yes	no	accep	accep	accep	no	38	35.0	5	0	
OW-46	Shallow OB	yes	yes	yes	no	accep	accep	accep	no	14.5	14	6	0	
OW-47	Deep OB	yes	yes	yes	no	accep	accep	nv	no	28	25.4	6	0	
OW-48	Shallow OB	yes	no	yes	no	accep	accep	nv	no	10	10.7	6	0	
OW-49	Bedrock	yes	yes	yes	no	accep	accep	accep	yes	70	69		0	
OW-50	Deep OB	yes	yes	yes	no	accep	accep	accep	yes	43	43	5	0	
OW-51	Shallow OB	yes	yes	yes	no	accep	accep	accep	yes	19	18.5		0	
OW-52	Bedrock	} located, but		---	---	---	---	---	---	52	---	---	---	Ronnies Inc.
OW-53	Deep OB	} denied access		---	---	---	---	---	---	21	---	---	---	
Barcad Well – "MW" Series														
MW-01	Bedrock	} Added to RI Program September 1994. No information is available since they were not inventoried with the "OW" –												
MW-01A	Deep OB	} series and "P" – series wells.												
MW-01B	Deep OB	}												
MW-01C	Shallow OB	}												

TABLE 2-4 (Continued). EXISTING WELL AND PIEZOMETER INVENTORY (1)

Well ID Number (2)	Formation Screened	Well ID Mark Present	Well Secured On Arrival	Well Plumb Level	PVC Cap Present	Condition of			Survey Mark Present	Depth to Bottom		Depth to Water (4) (ft TOC)	PID Reading (ppm)	Additional Comments
						PVC	Outer Casing	Concrete Pad		Inst. (3) (ft bgs)	Meas. (4) (ft bgs)			
Piezometers														
P-1	Shallow OB	no	no	yes	yes	accep	N/A	N/A	yes	9.75	9.2	7.9	0	Well Depth-10.5 ft TOC
P-2	Shallow OB	no	no	yes	yes	accep	N/A	N/A	not sure	7	5.3	6.5	0	0.1 ft of water
P-3	Shallow OB	no	no	yes	yes	accep	N/A	N/A	yes	9.6	7.2	6.8	0	Well Depth 9.5 ft TOC
P-4	Shallow OB	no	no	yes	yes	accep	N/A	N/A	yes	7.2	7.5	6	0	
P-5	Shallow OB	no	no	yes	yes	accep	N/A	N/A	no	8.8	7	5.4	0	
P-6	Shallow OB	not located		---	---	---	---	---	---	7	---	---		
P-7	Shallow OB	not located		---	---	---	---	---	---	9	---	---		Destroyed
P-8	Shallow OB	not located		---	---	---	---	---	---	9	---	---		
P-9	Shallow OB	no	no	yes	yes	accep	N/A	N/A	yes	8.5	8.5	6	0	
P-10	Shallow OB	no	no	yes	no	accep	N/A	N/A	no	12.75	10.8	dry	0	
P-11	Shallow OB	no	no	yes	yes	accep	N/A	N/A	yes	10	9.5	6	0	In Penn Culvert
P-12	Shallow OB	no	no	yes	yes	accep	N/A	N/A	yes	8.66	8.1	1.5 to oil	10	
P-13	Shallow OB	not located		---	---	---	---	---	---	13.8	---	---	---	6.5 ft of product in well
P-14	Shallow OB	not located		---	---	---	---	---	---	7	---	---	---	
P-15	Shallow OB	not located		---	---	---	---	---	---	13.8	---	---	---	
P-16	Shallow OB	not located		---	---	---	---	---	---	9.66	---	---	---	
P-17	Shallow OB	no	no	yes	yes	accep	N/A	N/A	no	8.5	8.5	5.5	0	
P-18	Shallow OB	not located		---	---	---	---	---	---	12	---	---	---	
P-19	Shallow OB	not located		---	---	---	---	---	---	13	---	---	---	

NOTES:
1. Well inventory was conducted July 13 – July 16, 1993
2. Well clusters are separated by spaces
3. Source: Table 5-1 – Phase 1A Report (CDM, 1987)
4. Measurements taken by M&E July 13 – July 16, 1993

accep – Acceptable Condition
dmgd – Damaged Condition
ft bgs – feet below ground surface
ft TOC – feet from top of casing
ID – Identification
illeg – illegible
N/A – Not Applicable
nv – Not Visible
OB – Overburden
pfh – possible frost heaving
ppm – parts per million

TABLE 2-5. SUMMARY OF PHYSICAL DATA FOR TEST PITS

Area of Concern/ Test Pit Location	Total Depth (feet bgs)	Materials Encountered	Depth of Fill (feet bgs)	Fill Description	Max. PID Reading (ppm)	Depth of Water Table (feet bgs)
B&M Railroad Landfill						
TP-01	8	fill, sand	0-3	f-c sand/slag, wood, metal, copper piping	0	5
TP-02	4.5	fill, sand	0-0.5	f-c sand/slag	0	4.3
TP-03	6.5	fill, sand	0-3	f-c sand/gravel, drum, bricks, metal scraps	0	5
TP-04	9	fill	0-9	f-c sand/gravel, RR ties/wood, scrap metal, brick, rubber	>1,000	5.5
TP-05	6	fill	0-6	f-c sand/gravel, wood, metal, tires, concrete	100	5.5
TP-06	13	fill	0-13	f-c sand, wood, metal, brick, tire, rubber	100	12
TP-07	8	fill	0-8	f-c sand, wood, metal, rubber, cardboard	150	5.5
TP-08	6	fill	0-6	f-c sand, wood, paper, plastic, rubber, brick, empty drum	100	2
TP-09	12	fill	0-12	f-c sand, wood, stone, metal, brick, cloth, rubber, empty drums	>100	UD
TP-10	7	fill	0-7	f-c sand, slag, wood, brick, metal, glass, rubber	0	6.5
TP-11	12	sand/gravel	0-12	f-c sand, wood, metal, plastic, glass, rubber	8	NE
TP-12	10	slag, sand, fill, peat	0-7	f-c sand/gravel, slag, brick, coal, metal, wood, rubber	0	5.5
TP-13	9	fill, peat	0-7.5	f-c sand, wood, metal	40	3
TP-14	9	slag, sand, peat	0-1.5	f-c sand, slag, brick	0	4.5
RSI Landfill						
TP-15	13	silt, fill, sand	0-11	f-c sand, paper, plastic, metal, wood	0	NE
TP-16	12	sand, fill	0-12	f-c sand, plastic, cloth, paper, metal, glass, brick	10	NE
TP-17	12	sand, fill	0-12	f-c sand, plastic, metal, wood, cloth, paper, glass	0	NE
TP-18	11.5	sand/gravel	0-9	f-c sand, paper, plastic	100	NE
TP-19	10	sand, fill	0-7.5	f-c sand, paper, plastic	0	NE
TP-20	11.5	sand, fill	0-7.5	f-m sand, paper, plastic	100	NE
B&M Locomotive Shop Disposal Area A						
TP-24	7	sand	0	none	0	3
B&M Locomotive Shop Disposal Area B						
TP-21	13	sand, fill	0-10	f-c sand, rubber, wood, brick, slag	0	12
TP-22	12.7	fill, stratified drift	0-7	sand, metal scraps	0	NE
TP-23	12.5	fill, stratified drift	0-7.5	sand, brick, rubber, metal, slag, wood	0	NE
Old B&M Oil/Sludge Recycling Area						
TP-25	8	sand, fill	0-8	sand, free product, stained soils	0	NE
TP-26	6	sand, fill	0-6	sand, stained soils	0	NE
TP-27	5	sand, fill	0-4	sand, oily sand	0	4.5

NOTES:
bgs - below ground surface
ppm - parts per million
f-c fine to coarse
f-m fine to medium
NE - Not Encountered
PID - Photoionization Detector
UD - Unable to Determine

TABLE 2-6. PHYSICAL DATA FROM SOIL BORINGS

Area of Concern/ Boring Location	Total Depth (feet bgs)	Materials Encountered	Depth of Fill (feet bgs)	Fill Description	Max. Headspace Reading (2) (ppm)	Depth of Water Table (feet bgs)
B&M Railroad Landfill						
BH-01	6.8	fill, gravel	0-6.8	topsoil, f-m sand, wood, metal	0	NE
BH-02	16	fill	0-16	f-m sand, metal, wood, glass, concrete	>10,000	15
BH-03	16	sand, fill	0-10	pieces of wood lodged in tip of spoon	145	14
BH-04	7	fill	0-7	f-m sand, foam, wood, metal	50	NE
BH-05	16	sand, fill, silt	0-10	f-m sand, tire, wood	90	11
BH-06	4	fill	0-4	f-m sand, wood, metal, glass	0	NE
BH-07	14.5	fill, silt	0-12	f-m sand, glass, wood, rubber	0	6
BH-08	11	sand, fill	0-2	f-m sand, wood	0	6
BH-09	15	fill, peat	0-10	f-m sand, wood	50	8
BH-10	14	fill, peat	0-10	f-m sand, wood, paper	300	11.5
BH-11	15	fill, peat	0-8	f-m sand, foam, wood	2	8.5
BH-12	16	fill, sand	0-12	f-m sand, metal, trash	18	4
BH-13	15	fill, peat	0-6	f-c sand, rubber, brick	23	6
BH-14	15	fill, peat	0-6	f-m sand, metal	0.1	5.5
RSI Landfill						
BH-15	7	sand	-	none	0	NE
BH-16	3	sand	-	none	0.1	NE
BH-17	15	sand	-	none	0	8.5
BH-18	15.3	sand	-	none	0	5.5
BH-19	13	sand	-	none	0	4.5
BH-20	7	sand	-	none	0	3.5
BH-21	15	fill	0-15	f-m sand, glass, cardboard, paper	7.5	NE
BH-22	14.5	fill	0-14.5	f-m sand, glass, metal, plastic, wood, rubber	0	14
BH-23	15	fill	0-15	f-m sand, plastic, ash, glass, metal	0	NE
BH-24	15	fill	0-15	f-c sand, wood, cloth	0	NE
BH-25	14	fill	0-10.5	f-m sand, brick, paper, plastic	0	NE
BH-26	14	fill	0-14	f-m sand, paper, glass, plastic	0	NE
B&M Locomotive Shop Disposal Area A						
BH-27	16	sand, peat	0-16	none	0	4
BH-28	12	fill, peat, sand	0-10.3	f-m sand, ash, coal, and wood	1.5	4.5

TABLE 2-6 (Continued). PHYSICAL DATA FROM SOIL BORINGS

Area of Concern/ Boring Location	Total Depth (feet bgs)	Materials Encountered	Depth of Fill (feet bgs)	Fill Description	Max. Headspace Reading (2) (ppm)	Depth of Water Table (feet bgs)
B&M Locomotive Shop Disposal Area B						
BH-29	15	fill, sand	0-10.5	f-m sand, ash, metal, plastic	0	14.5
BH-30	15	fill, sand	0-10	f-m sand, ash, glass, brick	0	NE
BH-31	15	fill, sand	0-10	f-m sand, ash, wood	0	13
BH-32	16	fill	0-16	f-m sand, metal, slag, foam, wood	0	13
BH-33	15	fill, sand	0-13.5	f-m sand, slag	90	9
BH-34	15	fill	0-15	f-m sand, slag, glue?, metal, wood	90	10
Old B&M Oil/Sludge Recycling Area						
BH-35	15	fill, sand	0-1.5	f-m sand, ash	0	7.5
BH-36	12	sand	-	none	0	8
BH-37	15	fill, sand, peat	0-3	f-m sand, ash	0	6.5
BH-38	15	fill, sand, silt	0-9	f-m sand, glass, foam, brick, oily silt	0	10
BH-39	15	fill, sand	0-5.5	f-m sand, oily silt	0	7.5
BH-40	16	fill, sand	0-11	f-m sand, oily silt	1,000	10
BH-41	15	fill	0-15	f-m sand, slag, wood	0	6
BH-42	15	fill, sand	0-4	f-m sand, slag	0	5
BH-43	13	sand, peat	-	none	55	8
BH-44	5	fill	0-5	f-m sand, wood, glass	80	NE
BH-45	8	sand	-	none	2	6
BH-46	10	fill, sand, gravel	0-2	f-m sand, gravel, ash, brick	10	6

NOTES:
1. Measured from the ground surface
2. Measured in the borehole headspace using a photoionization detector
3. Boring logs are presented in Appendix D

bgs - below ground surface
f-c fine to coarse
f-m fine to medium
NE - Not Encountered
ppm - parts per million

TABLE 2-7. HYDROGEOLOGIC GROUPINGS OF MONITORING WELLS AND PIEZOMETERS FOR AREAS OF CONCERN

Areas of Concern	Hydrogeological Relationship of Well and Piezometer Locations			
	Upgradient	Downgradient	In Source Area	In Vicinity (1)
Background				
Shallow Overburden	MW-200S, P-10	NONE	NONE	P-1, P-2, P-3
Deep Overburden	MW-200D, OW-06	NONE	NONE	NONE
Bedrock	MW-200B, OW-05	NONE	NONE	NONE
B&M Railroad Landfill				
Shallow Overburden	OW-36	NONE	PZ-113, PZ-114, PZ-115 MW-213S, MW-214S MW-215S	MW-1C (2)
Deep Overburden	OW-35	NONE	MW-213D, MW-214D, MW-215D	MW-1A, MW-1B, OW-50
Bedrock	OW-34	NONE	MW-213B, MW-214B, MW-215B	MW-01, OW-49
RSI Landfill				
Shallow Overburden	OW-26, OW-27 P-9	OW-03, PZ-110, PZ-112 MW-210S, MW-211S, MW-212S	PZ-111	OW-08
Deep Overburden	OW-25	OW-02 MW-211D, MW-212D	NONE	OW-07
Bedrock	MW-207B	OW-01 MW-210B, MW-211B, MW-212B	NONE	NONE
B&M Locomotive Shop Disposal Area				
Area A:				
Shallow Overburden	MW-204S	MW-206S, PZ-106A	PZ-104A, PZ-105A	OW-40
Deep Overburden	MW-204D	MW-206D	NONE	OW-39
Bedrock	MW-204B	MW-206B	NONE	NONE
Area B:				
Shallow Overburden	MW-204S	MW-205S	PZ-104B, PZ-106B	OW-40, PZ-105B
Deep Overburden	MW-204D	MW-205D	NONE	OW-39
Bedrock	MW-204B	MW-205B	NONE	NONE
Old B&M Oil/Sludge Recycling Area				
Shallow Overburden	MW-201S	MW-202S, MW-203S	OW-42, OW-43, P-12 P-11	OW-19 PZ-101, PZ-102, PZ-103, P-17
Deep Overburden	MW-201D	MW-202D, MW-203D, OW-47	OW-41	OW-18, OW-38
Bedrock	MW-201B	MW-202B, MW-203B, OW-37	NONE	OW-17
Asbestos Lagoons				
Shallow Overburden	MW-208S	OW-11, OW-12, OW-21, P-5	NONE	OW-14 PZ-107, PZ-108, PZ-109, P-4
Deep Overburden	MW-208D	OW-10, OW-20	NONE	OW-13
Bedrock	MW-208B	OW-09, MW-209B	NONE	NONE

NOTES:
1. "In Vicinity" is defined as a well that is within the immediate area being investigated, although not hydrogeologically upgradient, downgradient, or within the potential source area
2. OW-51 was not included since this well is not considered downgradient of the B&M Railroad Landfill because shallow overburden may be hydraulically connected to the pond

MW - designates new monitoring wells
OW - designates existing monitoring wells

TABLE 2-8. M&E-INSTALLED MONITORING WELL AND PIEZOMETER SPECIFICATIONS

Area of Concern/ Well ID	Formation Screened	Depth Screened (feet bgs)	Material Screened (1)	Sand Pack Depth (feet bgs)	Well-Seal Depth (feet bgs)
			Monitoring Wells		
Background					
MW-200S	Shallow OB	5.45-15.45	Albation Till	3.5-16.1	2.5-3.5
MW-200D	Deep OB	16.65-26.65	Basal Till	16.3-27.1	14.2-16.3
MW-200B	Bedrock	40.45-60.45	Diorite	32.15-61.0	24.15-32.15
B&M Railroad Landfill					
MW-213S	Shallow OB	7.4-17.4	Peat	5.1-20.6	3.0-5.1
MW-213D	Deep OB	41.3-51.3	Outwash	35.0-51.8	31.3-35.0
MW-213B	Bedrock	64.05-84.05	Granite	57.5-91.0	47.5-57.5
MW-214S	Shallow OB	15.1-25.1	Peat/Outwash	12.1-25.5	9.6-12.1
MW-214D	Deep OB	42.5-52.5	Outwash	39.0-53.0	34.0-39.0
MW-214B	Bedrock	68.55-88.55	Granite	61.5-89.0	52.0-61.5
MW-215S	Shallow OB	10.0-20.0	Outwash	6.0-20.5	3.0-6.0
MW-215D	Deep OB	39.6-49.6	Outwash	37.0-50.0	27.0-37.0
MW-215B	Bedrock	66.1-86.1	Granite	59.2-86.7	53.0-59.2
RSI Landfill					
MW-210S	Shallow OB	4.5-9.5	Albation Till	4.0-10.0	3.0-4.0
MW-210B	Bedrock	23.5-43.5	Granite	14.15-44.0	7.0-14.15
MW-211S	Shallow OB	5.0-15.0	Outwash	4.0-18.5	2.8-4.0
MW-211D	Deep OB	15.6-25.6	Albation Till	13.7-26.0	11.5-13.7
MW-211B	Bedrock	27.4-47.4	Granite	25.5-48.0	21.2-25.5
MW-212S	Shallow OB	5.1-15.1	Outwash	3.9-15.5	2.2-3.9
MW-212D	Deep OB	14.7-24.7	Outwash/Weathered Bedrock	12.6-25.9	10.2-12.6
MW-212B	Bedrock	31.75-51.75	Granite	29.0-52.3	25.0-29.0
B&M Locomotive Shop Disposal Area					
Area A					
MW-206S	Shallow OB	6.85-16.85	Outwash	4.8-17.2	3.2-4.8
MW-206D	Deep OB	12.9-22.9	Outwash	9.0-23.2	3.8-9.0
MW-206B	Bedrock	34.65-54.65	Granite	26.2-55.0	22.0-26.2
Area B					
MW-204S	Shallow OB	13.8-23.8	Albation Till	11.0-28.0	9.0-11.0
MW-204D	Deep OB	35.3-45.3	Outwash/Basal Till	32.0-45.5	29.0-32.0
MW-204B	Bedrock	55.2-75.2	Granite	52.0-75.4	48.0-52.0
MW-205S	Shallow OB	10.0-20.0	Outwash	8.0-20.5	6.3-8.0
MW-205D	Deep OB	20.65-30.65	Outwash	18.6-31.0	16.6-18.6
MW-205B	Bedrock	34.3-54.3	Granite	32.9-55.0	28.9-32.9

TABLE 2-8 (Continued). M&E-INSTALLED MONITORING WELL AND PIEZOMETER SPECIFICATIONS

Area of Concern/ Well ID	Formation Screened	Depth Screened (feet bgs)	Material Screened (1)	Sand Pack Depth (feet bgs)	Well-Seal Depth (feet bgs)
Old B&M Oil/Sludge Recycling Area					
MW-201S	Shallow OB	6.5-16.5	Peat/Albation Till	4.7-21.5	3.5-4.7
MW-201D	Deep OB	33.0-43.0	Basal Till	31.0-52.5	29.0-31.0
MW-201B	Bedrock	56.7-76.7	Granite	55.0-77.1	52.5-55.0
MW-202S	Shallow OB	6.0-16.0	Peat/Outwash	4.0-17.0	3.0-4.0
MW-202D	Deep OB	31.5-41.5	Outwash	28.0-42.0	26.0-28.0
MW-202B	Bedrock	80.0-100.0	Granite	75.0-100.0	71.0-75.0
MW-203S	Shallow OB	5.7-15.7	Outwash	3.7-16.0	1.7-3.7
MW-203D	Deep OB	32.5-42.5	Outwash	30.0-44.0	28.0-30.0
MW-203B	Bedrock	58.5-78.5	Granite	55.0-78.8	51.5-55.5
Asbestos Lagoons					
MW-208S	Shallow OB	9.0-19.0	Outwash	6.0-20.0	4.0-6.0
MW-208D	Deep OB	30.0-40.0	Outwash	27.00-44.00	25.0-27.0
MW-208B	Bedrock	64.00-84.00	Granite	60.0-84.0	56.00-60.00
MW-209B	Bedrock	44.8-64.8	Schist	41.0-65.0	37.0-41.0
Contaminated Soil Area					
MW-207B	Bedrock	104.35-124.35	Granite	96.0-124.7	90.0-96.0
			Piezometers		
B&M Railroad Landfill					
PZ-113	Shallow OB	17.5-22.5	Outwash	16.5-25.0	15.5-16.5
PZ-114	Shallow OB	13.6-18.6	Peat/Outwash	11.8-19.0	10.5-11.8
PZ-115	Shallow OB	13.6-18.6	Sandy Fill	13.6-18.6	10.5-11.8
RSI Landfill					
PZ-110	Shallow OB	5.6-9.6	Sandy Fill	3.2-10.3	2.2-3.2
PZ-111	Shallow OB	13.3-18.3	Sandy Fill/Outwash	4.0-18.6	3.0-4.0
PZ-112	Shallow OB	14.0-19.0	Outwash	3.2-20.0	2.2-3.2
B&M Locomotive Shop Disposal Area					
Area A					
PZ-104A	Shallow OB	9.5-14.5	Sandy Fill	3.5-14.7	2.9-3.5
PZ-105A	Shallow OB	9.4-14.6	Sandy Fill	2.0-14.6	1.0-2.0
PZ-106A	Shallow OB	4.8-10.1	Sandy Fill	3.0-10.1	1.0-3.0
Area B					
PZ-104B	Shallow OB	9.4-14.4	Outwash	5.0-15.0	4.0-5.0
PZ-105B	Shallow OB	9.0-14.0	Gravelly Fill	4.0-14.2	3.0-4.0
PZ-106B	Shallow OB	9.8-14.8	Outwash	7.0-15.0	6.0-7.0

TABLE 2-8 (Continued). M&E-INSTALLED MONITORING WELL AND PIEZOMETER SPECIFICATIONS

Area of Concern/ Well ID	Formation Screened	Depth Screened (feet bgs)	Material Screened (1)	Sand Pack Depth (feet bgs)	Well-Seal Depth (feet bgs)
Old B&M Oil/Sludge Recycling Area					
PZ-101	Shallow OB	4.3-9.3	Clayey Fill	2.0-9.5	1.0-2.0
PZ-102	Shallow OB	8.8-13.8	Outwash	3.0-14.0	2.0-3.0
PZ-103	Shallow OB	4.8-9.8	Sandy Fill	2.2-10.3	1.5-2.2
Asbestos Lagoons					
PZ-107	Shallow OB	3.5-8.5	Sandy Fill	3.5-9.0	3.0-3.5
PZ-108	Shallow OB	4.3-9.3	Sandy Fill	1.5-9.5	0.7-1.5
PZ-109	Shallow OB	8.5-13.5	Sandy and Gravelly Fill	8.5-13.5	6.0-7.0

NOTES:
1. Refer to Section 3.2.1 for description of lithologies
bgs - below ground surface
OB - overburden

TABLE 2-9. SUMMARY OF ENVIRONMENTAL SAMPLES AND ANALYSES

Parameter	Method	No. of Locations	No. of Samples	Field QA/QC Samples (1,2) Trip Blanks (3)	Bottle Blanks (4)	Equipment Blanks (5)	Field Duplicates	PE Samples	Total Collected
Surface Soil									
TCL Volatile Organics	CLP - RAS	365	79	10	--	6	8	--	103
TCL Semivolatile Organics	CLP - RAS	365	79	--	1	6	8	--	94
TCL Pesticides/PCBs	CLP - RAS	365	79	--	--	6	8	--	93
TAL Metals	CLP - RAS	365	79	--	--	6	8	--	93
Cyanide	CLP - RAS	365	79	--	--	6	8	--	93
Total Petroleum Hydrocarbons	CLP - SAS	365	79	--	--	6	8	--	93
Total Combustible Organics	D2974 (6)	365	14	--	--	--	3	--	17
Moisture Content	D2216 (6)	365	14	--	--	--	3	--	17
Test Pit Soil									
TCL Volatile Organics	CLP - RAS	24	24	6	--	3	3	--	36
TCL Semivolatile Organics	CLP - RAS	24	24	--	--	3	3	--	30
TCL Pesticides/PCBs	CLP - RAS	24	24	--	--	3	3	--	30
TAL Metals	CLP - RAS	24	24	--	--	3	3	--	30
Cyanide	CLP - RAS	24	24	--	--	3	3	--	30
Total Petroleum Hydrocarbons	CLP - SAS	24	24	--	--	3	3	--	30
Soil Borings									
TCL Volatile Organics	CLP - RAS	46	90	9	--	11	11	--	121
TCL Semivolatile Organics	CLP - RAS	46	81	--	--	11	11	--	103
TCL Pesticides/PCBs	CLP - RAS	46	81	--	1	11	11	--	104
TAL Metals	CLP - RAS	46	81	--	--	11	11	--	103
Cyanide	CLP - RAS	46	81	--	--	11	11	--	103
Total Petroleum Hydrocarbons	CLP - SAS	46	81	--	--	11	11	--	103
Total Combustible Organics	D2974 (6)	46	23	--	--	--	4	--	27
Moisture Content	D2216 (6)	46	23	--	--	--	1	--	24
Grain Size	D422-63 (6)	46	17	--	--	--	1	--	18
Porosity	D854 (6)	46	15	--	--	--	1	--	16
Permeability	SW9100 (6)	46	9	--	--	--	1	--	10
Specific Gravity	ASTMD-854	46	17	--	--	--	1	--	18
Surface Water-June 1993									
TCL Volatile Organics	CLP - RAS	46	46	10	1	6	5	--	68
TCL Semivolatile Organics	CLP - RAS	46	46	--	1	6	5	--	58
TCL Pesticides/PCBs	CLP - SAS	46	46	--	1	6	5	--	58
Total TAL Metals	CLP - RAS	46	46	--	2	6	5	--	59

TABLE 2-9 (Continued). SUMMARY OF ENVIRONMENTAL SAMPLES AND ANALYSES

Parameter	Method	No. of Locations	No. of Samples	Field QA/QC Samples (1,2): Trip Blanks (3)	Bottle Blanks (4)	Equipment Blanks (5)	Field Duplicates	PE Samples	Total Collected
Surface Water-June 1993 (Continued)									
Cyanide	CLP - RAS	46	46	--	2	6	5	--	59
Total Organic Carbon	CLP - SAS	46	46	--	2	6	5	--	59
Alkalinity	CLP - SAS	46	46	--	2	6	5	--	59
Hardness (7)	A2340-B	46	46	--	--	--	--	--	46
Temperature	E170.1	46	46	--	--	--	--	--	46
pH	E150.1	46	46	--	--	--	--	--	46
Specific Conductance	E120.1	46	46	--	--	--	--	--	46
Dissolved Oxygen	A4500-0-G	46	46	--	--	--	--	--	46
Surface Water-September 1993									
TCL Volatile Organics	CLP - RAS	42	42	7	1	5	5	3	63
TCL Semivolatile Organics	CLP - RAS	42	42	--	1	5	0	3	51
TCL Pesticides/PCBs	CLP - SAS	42	42	--	1	4	0	7	54
Total TAL Metals	CLP - RAS	42	42	--	1	5	5	10	63
Cyanide	CLP - RAS	42	42	--	0	5	5	9	61
Total Organic Carbon	DAS	42	42	--	1	1	5	--	49
Alkalinity	DAS	42	42	--	1	--	5	--	48
Hardness (7)	A2340-B	42	42	--	--	--	--	--	42
Temperature	E170.1	42	42	--	--	--	--	--	42
pH	E150.1	42	42	--	--	--	--	--	42
Specific Conductance	E120.1	42	42	--	--	--	--	--	42
Dissolved Oxygen	A4500-0-G	42	42	--	--	--	--	--	42
Sediment-June 1993									
TCL Volatile Organics	CLP - RAS	51	51	10	0	6	6	--	73
TCL Semivolatile Organics	CLP - RAS	51	51	--	1	6	6	--	64
TCL Pesticides/PCBs	CLP - RAS	51	51	--	0	7	6	--	64
TAL Metals	CLP - RAS	51	51	--	1	6	6	--	64
Cyanide	CLP - RAS	51	51	--	1	6	6	--	64
Total Petroleum Hydrocarbons	CLP - SAS	47	47	--	1	5	5	--	58
Total Organic Carbon	CLP - SAS	6	6	--	1	6	2	--	15
Total Combustible Organics	D2974 (6)	49	49	--	--	--	6	--	55
Grain Size	D422-63 (6)	47	47	--	--	--	5	--	52
Moisture Content	D2216 (6)	51	51	--	--	--	--	--	51

TABLE 2-9 (Continued). SUMMARY OF ENVIRONMENTAL SAMPLES AND ANALYSES

Parameter	Method	No. of Locations	No. of Samples	Field QA/QC Samples (1,2) Trip Blanks (3)	Bottle Blanks (4)	Equipment Blanks (5)	Field Duplicates	PE Samples	Total Collected
Sediment-September 1993									
TCL Volatile Organics	CLP - RAS	43	43	7	--	0	5	--	55
TCL Semivolatile Organics	CLP - RAS	43	43	--	--	0	5	--	48
TCL Pesticides/PCBs	CLP - RAS	43	43	--	--	4	5	3	51
TAL Metals	CLP - RAS	43	43	--	--	4	5	6	54
Cyanide	CLP - RAS	43	43	--	--	4	5	3	51
Total Petroleum Hydrocarbons	DAS	43	43	--	--	5	5	--	48
Total Organic Carbon	DAS	43	43	--	--	1	1	--	44
Total Combustible Organics	D2974 (6)	43	43	--	--	--	5	--	48
Grain Size	D422-63 (6)	43	43	--	--	--	5	--	48
Moisture Content	D2216 (6)	43	43	--	--	--	5	--	48
Groundwater Screening									
1,1-Dichloroethene	GC	50	50	--	--	1	--	--	51
Benzene	GC	50	50	--	--	1	--	--	51
Chlorobenzene	GC	50	50	--	--	1	--	--	51
Ethylbenzene	GC	50	50	--	--	1	--	--	51
Tetrachloroethene	GC	50	50	--	--	1	--	--	51
Toluene	GC	50	50	--	--	1	--	--	51
Total VOCs	GC	50	50	--	--	1	--	--	51
Vinyl Chloride	GC	50	50	--	--	1	--	--	51
cis - 1,2 - Dichloroethene	GC	50	50	--	--	1	--	--	51
m - Xylene	GC	50	50	--	--	1	--	--	51
o - Xylene	GC	50	50	--	--	1	--	--	51
Groundwater-March/April 1995									
TCL Volatile Organics	CLP - RAS	77	77	10	1	8	8	9	113
TCL Semivolatile Organics	CLP - RAS	77	77	--	1	8	8	9	103
TCL Pesticides/PCBs	CLP - RAS	77	77	--	1	8	8	9	103
Total Petroleum Hydrocarbons	CLP - RAS	77	77	--	1	8	8	9	103
Total TAL Metals	CLP - RAS	77	77	--	1	8	8	9	103
Cyanide	CLP - RAS	77	77	--	1	8	8	9	103
Total Organic Carbon	DAS	77	20	--	1	3	2	--	26
Alkalinity	DAS	77	20	3	1	3	2	--	29
Biological Oxygen Demand	DAS	77	20	--	1	3	2	--	26
Chloride	DAS	77	20	--	1	3	2	--	26

TABLE 2-9 (Continued). SUMMARY OF ENVIRONMENTAL SAMPLES AND ANALYSES

Parameter	Method	No. of Locations	No. of Samples	Field QA/QC Samples (1,2) Trip Blanks (3)	Bottle Blanks (4)	Equipment Blanks (5)	Field Duplicates	PE Samples	Total Collected
Groundwater–March/April 1995 (Continued)									
Chemical Oxygen Demand	DAS	77	20	--	1	3	2	--	26
Nitrate/Nitrite as Nitrogen	DAS	77	20	--	1	3	2	--	26
Total Phosphorous	DAS	77	20	--	1	3	2	--	26
Sulfate	DAS	77	20	--	1	3	2	--	26
Total Dissolved Solids	DAS	77	20	--	1	3	2	--	26
Total Suspended Solids	DAS	77	20	--	1	3	2	--	26
Hardness (7)	A2340-B	77	20	--	--	--	--	--	20
Temperature	E170.1	77	77	--	--	--	3	--	80
pH	E150.1	77	77	--	--	--	3	--	80
Specific Conductance	E120.1 (7)	77	77	--	--	--	3	--	80
Eh	2580B	77	77	--	--	--	--	--	77
Turbidity	180.1	77	77	--	--	--	--	--	77
Dissolved Oxygen	360.1	77	77	--	--	--	--	--	77
Groundwater–July 1995									
TCL Volatile Organics	CLP – RAS	77	77	9	1	8	8	4	107
TCL Semivolatile Organics	CLP – RAS	77	77	--	1	8	8	4	98
TCL Pesticides/PCBs	CLP – RAS	77	77	--	1	8	8	4	98
Total Petroleum Hydrocarbons	CLP – RAS	77	77	--	1	8	8	4	98
Total TAL Metals	CLP – RAS	77	77	--	1	8	8	4	98
Cyanide	CLP – RAS	77	77	--	1	8	8	4	98
Total Organic Carbon	DAS	77	20	--	1	2	2	--	25
Alkalinity	DAS	77	20	--	1	2	2	--	25
Biological Oxygen Demand	DAS	77	20	--	1	2	2	--	25
Chloride	DAS	77	20	--	1	2	2	--	25
Chemical Oxygen Demand	DAS	77	20	--	1	2	2	--	25
Nitrate/Nitrite as Nitrogen	DAS	77	20	--	1	2	2	--	25
Total Phosphorous	DAS	77	20	--	1	2	2	--	25
Sulfate	DAS	77	20	--	1	2	2	--	25
Total Dissolved Solids	DAS	77	20	--	1	2	2	--	25
Total Suspended Solids	DAS	77	20	--	1	2	2	--	25
Hardness (7)	A2340-B	77	77	--	1	8	8	4	98
Temperature	E170.1	77	77	--	--	--	--	--	77
pH	E150.1	77	77	--	--	--	--	--	77
Specific Conductance	E120.1 (7)	77	75	--	--	--	--	--	75

TABLE 2-9 (Continued). SUMMARY OF ENVIRONMENTAL SAMPLES AND ANALYSES

Parameter	Method	No. of Locations	No. of Samples	Field QA/QC Samples (1,2) Trip Blanks (2)	Bottle Blanks (3)	Equipment Blanks (4)	Field Duplicates	PE Samples	Total Collected
Groundwater – July 1995 (Continued)									
Eh	2580B	77	77	--	--	--	--	--	77
Turbidity	180.1	77	65	--	--	--	--	--	65
Dissolved Oxygen	360.1	77	74	--	--	--	--	--	74

NOTES:
1. Matrix spike/spike duplicates (MS/MSDs) were collected for each medium; CLP RAS (organic and inorganic), SAS, and DAS methods require the submittal of 1 sample in 20 for MS/MSD analysis
2. A field blank was taken for VOC, SVOC, pesticides/PCP, TPH, metals, cyanide, TOC, and alkalinity
3. A trip blank sample was submitted with each shipment for volatile organic analysis
4. Bottle blanks were collected for each lot of sample bottles used for each medium
5. The number of equipment blanks is approximately equal to 10% of the number of samples for each medium and area
6. These parameters were collected in soil samples to characterize geotechnical parameters and in sediment samples for ecological evaluations
7. Measurements of pH, specific conductance, and temperature were taken if there was sufficient sample volume
8. Hardness was calculated; no additional sample volume was needed

CLP – Contract Laboratory Program
DAS – Delivery of Analytical Services
GC – Gas Chromatography
PCB – Polychlorinated Biphenyl
RAS – Routine Analytical Services
SAS – Special Analytical Services
TAL – Target Analyte List
TCL – Target Compound List

Analytical Methods:
CLP – RAS Organics: Contract Laboratory Program Statement of Work for Organic Analysis (Multi-Media Concentration), Document No. OLM01.0 including revisions OLM01.1 through OLM01.9, July 1993 (U.S. EPA, 1993b)
CLP – RAS Inorganics: Contract Laboratory Program Statement of Work for Inorganic Analysis (Multi-Media Concentration), Document No. ILM02.0 with revisions through ILM03.0, July 1993 (U.S. EPA, 1993c)
E method series: Method for Chemical Analysis for Water and Wastes (U.S. EPA, 1983)
D method series: Annual Book of ASTM Methods (ASTM, 1992).
SW method series: Test Methods for Evaluating Solid Waste, SW846, 3rd ed. (U.S. EPA, 1986)
A method series: Standard Methods for Examination of Water and Wastewater, 18th ed. (APHA, 1992)

TABLE 2-10. SURFACE SOIL, SOIL BORING, TEST PIT, AND GROUNDWATER-SCREENING LOCATIONS BY AREA OF CONCERN

Media	Background	Total No:	B&M Railroad Landfill	Total No:	RSI Landfill	Total No:	B&M Locomotive Shop Disposal Area A	Total No:
Surface Soil	SS-11 to SS-13	3	SS-61 to SS-74	14	SS-05 to SS-10	6	SS-04	1
Soil Borings	None	0	BH-01 to BH-14	14	BH-15 to BH-26	12	BH-27 to BH-28	2
Test Pits	None	0	TP-01 to TP-14	14	TP-15 to TP-20	6	TP-24	1
GW-Screening	None	0	GW-41 to GW-50	10	GW-01 to GW-10	10	GW-21 to GW-22	2

Media	B&M Locomotive Shop Disposal Area B	Total No:	Old B&M Oil/Sludge Recycling Area	Total No:	Asbestos Lagoons	Total No:	Soil Contaminated Area	Total No:
Surface Soil	SS-01 to SS-03	3	SS-78 to SS-83	6	None	0	SS-14 to SS-59	46
Soil Borings	BH-29 to BH-34	6	BH-35 to BH-46	12	None	0	None	0
Test Pits	TP-21 to TP-23	3	TP-25 to TP-27	3	None	0	None	0
GW-Screening	GW-23 to GW-28	6	GW-11 to GW-20	10	GW-31 to GW-40	10	None	0

NOTES:
1. Soil boring depths of samples submitted for analysis are shown in Table 2-11
2. Test pit depths of samples submitted for analysis are shown in Table 2-12

TABLE 2-11. SUMMARY OF TEST PIT SAMPLING LOCATIONS AND DEPTHS

B&M Railroad Landfill		RSI Landfill		B&M Locomotive Shop Disposal Area A		B&M Locomotive Shop Disposal Area B		Old B&M Oil/Sludge Recycling Area
Sample Location	Depth (feet bgs)	Sample Location	Depth (feet bgs)	Sample Location	Depth (feet bgs)	Sample Location	Depth (feet bgs)	Sample Location
TP-01	3.0-3.5	TP-15	12.0-13.0	TP-24	2.0-2.5	TP-21	10.0-10.5	None
TP-02	3.8-4.0	TP-16	11.0-12.0			TP-22	5.0-7.0	
TP-03	2.8-3.2	TP-17	11.0-12.0			TP-23	7.0-8.0	
TP-04	5.0-5.2	TP-18	9.5-10.0					
TP-05	4.5-5.0	TP-19	9.0-10.0					
TP-06	9.0-9.2	TP-20	8.0-9.0					
TP-07	4.0-4.2							
TP-08	1.0-2.0							
TP-09	3.5-4.5							
TP-10	2.0-2.5							
TP-11	5.0-6.0							
TP-12	1.5-2.0							
TP-13	2.0-2.5							
TP-14	1.5-2.0							

NOTES:
bgs - below ground surface

TABLE 2-12. SUMMARY OF SOIL BORING SAMPLING LOCATIONS AND DEPTHS

Area of Concern/ Boring Location	Depth of VOC Sample (feet bgs)	Depth of All Other Chemical Parameters (feet bgs) (1)	Depth of Geotechnical Sample (feet bgs) (2)
B&M Railroad Landfill			
BH-01	0-2	0-2	0-2 (TCO,PERM,SMC)
BH-01	2-4	--	--
BH-02	5-7	--	--
BH-02	7-9		
BH-02	--	5-11	5-11 (TCO,SMC)
BH-03	4-6	--	--
BH-03	--	4-8	4-8 (SG,GRSZ,POR,TCO,SMC)
BH-03	8-10	--	--
BH-03	--	--	14-16 (PERM)
BH-04	0-2	--	--
BH-04	--	0-4	0-4 (SMC,TCO)
BH-04	4-6	--	4-6 (PERM)
BH-05	--	0-4	--
BH-05	2-4	--	--
BH-05	6-8	6-8	6-8 (SG,GRSZ,POR,TCO,SMC)
BH-06	0-2	--	--
BH-06	--	0-4	--
BH-07	0-2	0-2	--
BH-07	2-4	2-6	--
BH-08	0-2	0-2	0-2 (SG,GRSZ,POR,TCO,SMC)
BH-08	2-4	2-6	2-6 (SG,GRSZ,POR,TCO,PERM,SMC)
BH-08	4-6	--	--
BH-09	0-2	0-2	0-2 (SMC,TCO)
BH-09	2-4	2-4	--
BH-09	--	--	4-6 (PERM)
BH-09	--	--	4-8 (SG,GRSZ,POR)

TABLE 2-12 (Continued). SUMMARY OF SOIL BORING SAMPLING LOCATIONS AND DEPTHS

Area of Concern/ Boring Location	Depth of VOC Sample (feet bgs)	Depth of All Other Chemical Paramters (feet bgs) (1)	Depth of Geotechnical Sample (feet bgs) (2)
BH-09	--	--	11-15 (TCO,SMC)
BH-10	6-8	4-6	--
BH-10	8-10	6-8	--
BH-11	0-2	0-4 (METU,CN,TPH)	--
BH-11	2-4	4-6(2 SVOC,P/P)	4-6 (SG,GRSZ,POR)
BH-11	--	--	8-10 (TCO,SMC)
BH-11	--	--	13-15 (SG,GRSZ)
BH-12	0-2	0-2	--
BH-12	2-4	2-4	--
BH-13	0-2	0-2	--
BH-13	4-6	4-6	--
BH-14	2-4	4-8	--
BH-14	4-6	--	--
RSI Landfill			
BH-15	2-4	2-4	--
BH-15	4-6	4-6	--
BH-16	0-2	0-2	--
BH-16	2-3	2-3	--
BH-17	--	--	2-4 (PERM)
BH-17	4-6	4-6	4-6 (TCO,SMC)
BH-17	6-8	6-8	6-8 (SG,GRSZ,POR)
BH-18	0-2	0-2	--
BH-18	2-4	2-4	--
BH-19	2-4	2-4	--
BH-19	4-6	4-6	4-6 (SG,GRSZ,POR,TCO,SMC)

TABLE 2-12 (Continued). SUMMARY OF SOIL BORING SAMPLING LOCATIONS AND DEPTHS

Area of Concern/ Boring Location	Depth of VOC Sample (feet bgs)	Depth of All Other Chemical Paramters (feet bgs) (1)	Depth of Geotechnical Sample (feet bgs) (2)
BH-20	2-3	2-3	--
BH-20	4-6	--	--
BH-21	8-10	8-10	--
BH-21	10-12	10-12	--
BH-22	--	0-2	--
BH-22	2-4	--	--
BH-22	6-8	6-8	--
BH-23	4-8	4-8	--
BH-23	10-12	10-12	--
BH-24	4-6	4-10	--
BH-24	--	13-15	--
BH-25	8-10	8-10	8-10 (SG,POR,GRSZ,TCO,SMC)
BH-25	12-14	12-14	12-14 (SG,POR,GRSZ,TCO,SMC)
BH-26	2-4	2-4	2-4 (TCO,SMC)
BH-26	12-14	12-14	--
B&M Locomotive Shop Disposal Area A			
BH-27	0-2	0-2	0-2 (SG,GRSZ,TCO,SMC)
BH-28	0-2	0-2	--
BH-28	2-4	2-4	--
B&M Locomotive Shop Disposal Area B			
BH-29	8-10	2-10	2-10 (SMC,TCO)
BH-29	10-12	10-12	10-15 (SG,POR,GRSZ,TCO,SMC)
BH-29	--	--	10-13 (PERM - 2 SAMPLES)
BH-30	0-2	0-2	--
BH-30	2-4	2-4	--

TABLE 2-12 (Continued). SUMMARY OF SOIL BORING SAMPLING LOCATIONS AND DEPTHS

Area of Concern/ Boring Location	Depth of VOC Sample (feet bgs)	Depth of All Other Chemical Paramters (feet bgs) (1)	Depth of Geotechnical Sample (feet bgs) (2)
BH-31	2-4	2-4	--
BH-31	4-6	4-6	--
BH-32	8-10	8-10	--
BH-32	10-12	10-12	10-12 (SG,POR,GRSZ,TCO,SMC)
BH-33	0-2	0-2	--
BH-33	2-4	2-4	--
BH-34	2-4	2-4	--
BH-34	4-6	4-6	--
BH-34	8-10	--	--
Old B&M Oil/Sludge Recycling Area			
BH-35	2-4	2-6	--
BH-35	4-6	6-8	6-8 (PERM)
BH-36	--	2-6	2-6 (SG,POR,GRSZ,TCO,SMC)
BH-36	4-6	--	--
BH-36	6-8	6-8	6-8 (TCO,SMC)
BH-37	--	2-4	2-4 (PERM)
BH-37	4-6	--	--
BH-37	6-8	--	--
BH-38	6-8	6-8	--
BH-38	8-10	8-10	8-10 (SG,POR,TCO,GRSZ,SMC)
BH-39	2-4	2-4	--
BH-39	4-6	--	--
BH-40	8-10	8-10	--
BH-40	10-12	10-12	10-12 (SG,TCO,GRSZ,POR,SMC)

TABLE 2-12 (Continued). SUMMARY OF SOIL BORING SAMPLING LOCATIONS AND DEPTHS

Area of Concern/ Boring Location	Depth of VOC Sample (feet bgs)	Depth of All Other Chemical Paramters (feet bgs) (1)	Depth of Geotechnical Sample (feet bgs) (2)
BH-41	0-2	0-2	--
BH-41	2-4	2-4	--
BH-42	2-4	2-4	--
BH-42	4-6	4-6	--
BH-43	--	0-2	--
BH-43	2-4	2-4	--
BH-43	6-8	--	--
BH-44	0-2	0-2	--
BH-44	4-5	2-5	--
BH-45	0-2	0-4	--
BH-45	2-4	--	--
BH-46	0-2	0-4	--
BH-46	4-6	4-6	--

NOTES:
1. Chemical parameters include: semivolatile organics (SVOC), total metals (METU), total cyanide (CN), total petroleum hydrocarbons (TPH), pesticides and PCBs (P/P)
2. Geotechnical parameters include:

GRSZ - Grain Size
PERM - permeability
POR - porosity
SG - specific gravity

SMC - soil moisture content
TCO - total combustible organics
VOC - volatile organic compound

bgs - below ground surface

TABLE 2-13. SUMMARY OF SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

Area of Concern	Surface Water High Flow/Low Flow June 1993/Sept. 1993	Sediment High Flow/Low Flow June 1993/Sept. 1993
West of Pond Street		
Background	SW-319/319A(1) SW-321	SD-319/319A(1) SD-321
B&M Pond	SW-017 SW-107 SW-304	SD-017 SD-107 SD-304
Drainage Ditch	SW-305 SW-306	SD-305 SD-306
B&M Locomotive Shop Disposal Areas (man-made canal)	SW-317	SD-317
North of Spincraft	SW-109/(2)	SD-109/(2)
RSI Wetland Area	SW-016 SW-108/(2) SW-301 SW-302 SW-303	SD-016 SD-108/(2) SD-301 SD-302 SD-303
Unnamed Brook (north of B&M Locomotive Shop Disposal Area)	SW-010 SW-013 SW-118 SW-322	SD-010 SD-013 SD-118 SD-322
Middlesex Canal (west of Pond Street)	SW-026 SW-028 SW-029 SW-307 SW-308	SD-026 SD-028 SD-029 SD-307 SD-308
Near Former Salt/Sand Pile (3)	-	SD-318/(4)
Asbestos Lagoons (3)	- - - -	SD-323/(4) SD-324/(4) SD-325/(4) SD-326/(4)

TABLE 2-13 (Continued). SUMMARY OF SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

Area of Concern	Surface Water High Flow/Low Flow June 1993/Sept. 1993	Sediment High Flow/Low Flow June 1993/Sept. 1993
East of Pond Street		
Content Brook	SW-030	SD-030
	SW-101	SD-101
	SW-102	SD-102
	SW-113	SD-113
	SW-117	SD-117
Middlesex Canal (east of Pond Street)	SW-019	SD-019
	SW-020	SD-020
	SW-103	SD-103
	SW-104	SD-104
	SW-105	SD-105
	SW-106	SD-106
	SW-116	SD-116
Richardson Pond	SW-022/(2)	SD-022
	SW-111	SD-111
	SW-309	SD-309
	SW-314	SD-314
	SW-315	SD-315
	SW-316	SD-316
	SW-320	SD-320
Shaffer Landfill Wetlands	SW-310	SD-310
	SW-311/(2)	SD-311/(2)
	SW-312	SD-312
	SW-313	SD-313

NOTES:
1. Location SW-319 was not sampled during September 1993 due to dry conditions; a new location, SW-319A was placed in the same vicinity and was sampled during September 1993
2. These locations were not sampled during September 1993 due to dry conditions
3. Although these samples were collected in conjunction with sediment samples, they are considered to be surface soil samples
4. These locations were not sampled during September 1993 as instructed by EPA

TABLE 2-14. SUMMARY OF MONITORING WELL SAMPLING LOCATIONS (1)

Area of Concern	Monitoring Well Locations: Shallow Overburden	Deep Overburden	Bedrock
Background	MW-200S	MW-200D OW-06(2)	MW-200B OW-05
B&M Railroad Landfill	MW-213S MW-214S MW-215S OW-36 MW-1C	MW-213D MW-214D MW-215D OW-35 OW-50 MW-1A(2) MW-1B(2)	MW-213B MW-214B MW-215B OW-34 OW-49 MW-1(2)
RSI Landfill	MW-210S MW-211S MW-212S OW-03 OW-08 OW-26 OW-27	MW-211D MW-212D OW-02 OW-07 OW-25	MW-207B MW-210B MW-211B MW-212B OW-01
B&M Locomotive Shop Disposal Areas (A&B)	MW-204S MW-205S MW-206S OW-40	MW-204D MW-205D MW-206D OW-39	MW-204B MW-205B MW-206B
Old B&M Oil/Sludge Recycling Area	MW-201S MW-202S MW-203S OW-19 OW-42 OW-43	MW-201D MW-202D MW-203D OW-18 OW-38 OW-41	MW-201B MW-202B MW-203B OW-17 OW-37
Asbestos Lagoons	MW-208S OW-11 OW-12 OW-14 OW-21	MW-208D OW-10 OW-13 OW-20	MW-208B MW-209B OW-09

NOTES:
1. Refer to Table 2-7 for hydrogeologic groupings
2. No samples were taken because well was dry during both sampling rounds

TABLE 2-15. SUMMARY OF MONITORING WELL SAMPLING TECHNIQUES

Well ID	Formation Screened	Sampling Method March/April 1995	Sampling Method July 1995
OW-01	Bedrock	(1)	(1)
OW-02	Deep OB	(1)	(1)
OW-03	Shallow OB	(1)	(1)
OW-05	Bedrock	(1)	(1)
OW-07	Deep OB	(1)	(1)
OW-08	Shallow OB	(1)	(1)
OW-09	Bedrock	(1)	(1)
OW-10	Deep OB	(1)	(1)
OW-11	Shallow OB	(1)	(1)
OW-12	Shallow OB	(6)	(2)
OW-13	Deep OB	(1)	(1)
OW-14	Shallow OB	(1)	(1)
OW-15	Deep OB	(1)	(1)
OW-16	Shallow OB	(1)	(1)
OW-17	Bedrock	(1)	(1)
OW-18	Deep OB	(1)	(1)
OW-19	Shallow OB	(1)	(1)
OW-20	Deep OB	(1)	(2)
OW-21	Shallow OB	(1)	(1)
OW-25	Deep OB	(1)	(1)
OW-26	Shallow OB	(1)	(1)
OW-27	Shallow OB	(1)	(1)
OW-34	Bedrock	(1)	(1)
OW-35	Deep OB	(1)	(2)
OW-36	Shallow OB	(1)	(1)
OW-37	Bedrock	(1)	(5)
OW-38	Deep OB	(1)	(1)
OW-39	Deep OB	(1)	(9)
OW-40	Shallow OB	(4)	(1)
OW-41	Deep OB	(1)	(1)
OW-42	Shallow OB	(1)	(1)
OW-43	Shallow OB	(1)	(1)
OW-49	Bedrock	(1)	(1)
OW-50	Deep OB	(1)	(1)
MW-1A	Deep OB	(1)	Not Sampled (10)
MW-1C	Shallow OB	(1)	Not Sampled (10)
MW-200S	Shallow OB	(8)	(8)
MW-200D	Deep OB	(8) and Turbidity > 5 NT	(5)
MW-200B	Bedrock	(8) and Turbidity > 5 NT	(1)
MW-201S	Shallow OB	(1)	(1)
MW-201D	Deep OB	(1)	(2)
MW-201B	Bedrock	(1)	(1)
MW-202S	Shallow OB	(1)	(1)
MW-202D	Deep OB	(1)	(1)
MW-202B	Bedrock	(4)	(2)
MW-203S	Shallow OB	(1)	(1)
MW-203D	Deep OB	(1)	(1)
MW-203B	Bedrock	(1)	(2)
MW-204S	Shallow OB	(1)	(1)
MW-204D	Deep OB	(1)	(2)
MW-204B	Bedrock	(1)	(5)
MW-205S	Shallow OB	(1)	(1)
MW-205D	Deep OB	(1)	(1)
MW-205B	Bedrock	(1)	(2)

TABLE 2-15 (Continued). SUMMARY OF MONITORING WELL SAMPLING TECHNIQUES

Well ID	Formation Screened	Sampling Method: March/April 1995	Sampling Method: July 1995
MW-206S	Shallow OB	(1)	(1)
MW-206D	Deep OB	(1)	(1)
MW-206B	Bedrock	(1)	(2)
MW-207B	Bedrock	(1)	(1)
MW-208S	Shallow OB	(1)	(1)
MW-208D	Deep OB	(1)	(1)
MW-208B	Bedrock	(1)	(3)
MW-209B	Bedrock	(1)	(2)
MW-210S	Shallow OB	(1)	(1)
MW-210B	Bedrock	(1)	(2)
MW-211S	Shallow OB	(1)	(1)
MW-211D	Deep OB	(1)	(1)
MW-211B	Bedrock	(1)	(2)
MW-212S	Shallow OB	(1)	(1)
MW-212D	Deep OB	(1)	(1)
MW-212B	Bedrock	(1)	(1)
MW-213S	Shallow OB	(1)	(1)
MW-213D	Deep OB	(1)	(1)
MW-213B	Bedrock	(4,7)	(2)
MW-214S	Shallow OB	(1)	(1)
MW-214D	Deep OB	(1)	(1)
MW-214B	Bedrock	(1)	(1)
MW-215S	Shallow OB	(1)	(1)
MW-215D	Deep OB	(1)	(1)
MW-215B	Bedrock	(1)	(2)

NOTES:

1. Well was sampled after removing three well screen volumes at < 500 ml/min with < 0.3-foot drawdown and all field parameters stable; turbidity is stable at < 5 NTU
2. Well was sampled after removing one well screen volume at lowest possible flow rate with drawdown no more than 2/3 of standing water above screened interval removed and all field parameters stable (within 10% during three consecutive readings)
3. Sampled after 4 hours of purging
4. Well was sampled after removing three well screen volumes at < 500 ml/min with < 0.3 feet draw down and all field paramters stable (within 10% during three consecutive readings); turbidity stable at > 5 NTU
5. Well was sampled after removing one well screen volume at lowest possible flow rate with draw down no more than 2/3 of standing water above screened interval removed and all field parameters stable (within 10% during three consecutive readings); turbidity stable at > 5 NTU
6. Tubing was placed 2 feet above bottom of well
7. Tubing was placed 1 foot above bottom of well
8. Sampling was achieved as described in #1 by starting and stopping pump to allow well to recharge
9. Pumped for 3 hours at <500 ml/min with <0.3-foot drawdown and all field parameters stable; turbidity stable at > 5 NTU
10. Not sampled beause Well B was dry at time of sampling

TABLE 3-1. SUMMARIES OF GEOTECHNICAL DATA BY AREA AND STRATIGRAPHIC UNIT

Area/Well Location	Depth Interval	Grain Size (1) Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Organic Content (%)(2)	Moisture Content (%)	Porosity (%)(3)	Specific Gravity	Hydraulic Conductivity (cm/sec)(4)
		SUMMARY OF GEOTECHNICAL DATA BY AREA (5)								
B&M Railroad Landfill										
MW-214B	39.0-41.0	10	88	NA	NA	0.3	15	0.4	2.8	24
MW-215B	13.5-15.5	0	94	NA	NA	0.3	25	0.4	2.7	9.1
	46.0-48.0	2	87	NA	NA	0.2	21	0.4	2.7	23
RSI Landfill										
MW-210S	5.0-7.0	12	58	56	2.0	0.4	11	0.25	2.8	0.03
MW-211B	11.0-15.0	8	90	NA	NA	0.3	19	0.4	2.7	11
	16.0-18.0	22	75	NA	NA	0.2	21	0.4	2.7	96
B&M Locomotive Shop Disposal Areas										
MW-204D	31.5-33.5	51	27	18	4	0.2	6.6	0.2	2.7	0.00004
MW-205B	15.0-17.0	0	69	31	0	0.3	28	0.4	2.7	6.5
B&M Oil/Sludge Recycling Area										
MW-201B	11.0-15.0	11	63	23	3	0.2	15	0.2	2.7	0.2
	41.0-45.0	14	48	25	13	0.4	11	0.2	2.6	0.003
MW-202B	29.0-31.0	0	97	NA	NA	0.2	24	0.4	2.7	20
	47.0-49.0	8	22	30	40	0.8	17	0.3	2.7	0.00012
Asbestos Lagoons										
MW-208B	24.0-26.0	3	93	NA	NA	0.3	20	0.3	2.7	40
	47.0-51.0	34	53	11	2	0.2	10	0.3	2.7	0.6
MW-209B	8.0-12.0	0	94	NA	NA	0.2	20	0.4	2.7	NA
	23.0-25.0	0	97	NA	NA	0.3	21	0.3	2.7	3.7
MW-209S	20.0-24.0	1	96	NA	NA	0.3	21	0.4	2.7	21

TABLE 3-1 (Continued). SUMMARIES OF GEOTECHNICAL DATA BY AREA AND STRATIGRAPHIC UNIT

Stratigraphic Unit/Parameter	Grain Size (1) Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Organic Content (%)(2)	Moisture Content (%)	Porosity (%)(3)	Specific Gravity	Hydraulic Conductivity (cm/sec)(4)
STATISTICAL SUMMARY OF GEOTECHNICAL DATA BY STRATIGRAPHIC UNIT (6)									
Fill									
Arithmetic Average	14	74	11	0.6	4.4	10	0.5, 0.5	2.6	0.003
Standard Deviation	13	15	3.9	1.1	5.4	7.4	0.05, 0.04	0.1	0.003
Number of Samples	11	11	11	11	15	15	11, 11	11	4
Maximum Value	42	89	20	3	18	27	0.6, 0.5	2.7	0.01
Minimum Value	1	47	5	0	0.3	2.3	0.4, 0.4	2.5	0.0004
Peat									
Arithmetic Average	21	52	25	3	21	63	0.5, 0.4	2.3	NA
Standard Deviation	17	2	13	3	16	31	(7)	0.3	NA
Number of Samples	2	2	2	2	3	3	1, 1	2.0	NA
Maximum Value	38	53	37	6	40	89	0.5, 0.4	2.6	NA
Minimum Value	4	50	12	0	1.55	19	0.5, 0.4	2	NA
Outwash									
Arithmetic Average	8.9	80	21	2.7	1.3	18	0.5, 0.5	2.7	15
Standard Deviation	11	17	9.1	3.8	3.7	5.7	0.1, 0.1	0.03	23
Number of Samples	17	17	6	6	19	19	3, 3	17	18
Maximum Value	38	97	32	11	17	28	0.7, 0.6	2.8	96
Minimum Value	0	48	10	0	0.2	5.3	0.5, 0.4	2.6	0.00001
Ablation Till									
Arithmetic Average	12	61	40	2.5	0.3	13	0.3	2.7	0.09
Standard Deviation	0.5	2.5	17	0.5	0.08	2.2	0.01	0.03	0.06
Number of Samples	2	2	2	2	2	2	2	2	2
Maximum Value	12	63	56	3	0.4	15	0.3	2.8	0.2
Minimum Value	11	58	23	2	0.2	11	0.2	2.7	0.03

TABLE 3-1 (Continued). SUMMARIES OF GEOTECHNICAL DATA BY AREA AND STRATIGRAPHIC UNIT

Stratigraphic Unit/Parameter	Grain Size (1) Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Organic Content (%)(2)	Moisture Content (%)	Porosity (%)(3)	Specific Gravity	Hydraulic Conductivity (cm/sec)(4)
	STATISTICAL SUMMARY OF GEOTECHNICAL DATA BY STRATIGRAPHIC UNIT (6) (continued)								
Basal Till									
Arithmetic Average	19	34	27	21	0.5	12	0.2	2.7	0.01
Standard Deviation	17	9	7.1	12	0.3	4.9	0.05	0.02	0.01
Number of Samples	5	5	5	5	5	5	5	5	5
Maximum Value	51	48	39	40	0.9	19	0.3	2.7	0.03
Minimum Value	2	22	18	4	0.2	6.6	0.2	2.6	0.00004

NOTES:

1. ASTM Method D422-63, Annual Book of Methods (1992).
2. ASTM Method D2974, Annual Book of Methods (1992)
3. Where two values are provided, the first was calculated using minimum density and specific gravity, the second using maximum density and specific gravity.
4. SW846 Method SW9100, Test Methods for Evaluating Solid Waste, SW846, 3rd ed. (1986)
5. Geotechnical data from samples obtained during MW-series monitoring well installations.
6. Statistical computations incorporate data from soil borings and monitoring wells.
7. Only one sample analyzed, therefore no standard deviation.

NA = not available

TABLE 3-2. MONITORING WELL SPECIFICATIONS AND DEVELOPMENT DATA (1)

Well ID	Location	Formation Screened	Ground Elevation	Screened Interval (ft bgs)	Screened Elevation	Material Screened	Depth of Well (ft bgs)	Date Developed	Volume Removed (gallons)	Final pH	Final Conductivity (μmhos/cm)	Final Temp. (^{o}C)	Final Turbidity (NTU)
MW-200S	Background	SOB	131.44	5.5-15.5	125.9 - 115.9	AT	16.1	02/09/95	36.9	6.08	221	4.1	999
MW-200D	Background	DOB	131.43	16.7-26.7	114.7 - 104.7	BT	27.1	02/10/95	106	8.27	135	7.5	999
MW-200B	Background	BR	131.42	40.5-60.5	90.9 - 70.9	Granodiorite	60.9	02/09/95	27.75	8.49	134	6.3	77
MW-201S	Oil/Sludge Recycling	SOB	121.53	6.5-16.5	115.0 - 105.0	Peat/AT	16.9	02/17/95	41	6.76	151	5.6	999
MW-201D	Oil/Sludge Recycling	DOB	121.17	33.0-43.0	88.2 - 78.2	BT	43.4	02/21/95	163.4	10.08	221	8.6	999
MW-201B	Oil/Sludge Recycling	BR	121.26	56.7-76.7	64.6 - 44.6	Granite	77.1	02/17/95	97	8.32	130	10.9	48
MW-202S	Oil/Sludge Recycling	SOB	115.39	6.0-16.0	109.4 - 99.4	Outwash	100.0	02/22-23/95	268	7.60	236	7.9	31
MW-202D	Oil/Sludge Recycling	DOB	115.18	31.5-41.5	83.7 - 73.7	Outwash	41.5	02/22/95	480	7.21	428	10.1	590
MW-202B	Oil/Sludge Recycling	BR	114.96	80.0-100.0	35.0 - 15.0	Granite	16.0	02/22/95	99	10.03	175	13.4	325
MW-203S	Oil/Sludge Recycling	SOB	116.31	5.7-15.7	110.6 - 100.6	Peat/Outwash	16.0	02/21/95	159	7.03	212	7.8	146
MW-203D	Oil/Sludge Recycling	DOB	115.39	32.5-42.5	82.9 - 72.9	Outwash	42.5	02/21/95	337.5	7.34	281	8.7	57
MW-203B	Oil/Sludge Recycling	BR	115.41	58.5-78.5	56.9 - 36.9	Granite	78.8	02/21/95	37.5	9.73	240	8.7	377
MW-204S	Loco. Shop Disp. Area B	SOB	130.00	13.8-23.8	116.2 - 106.2	AT	24.0	02/23/95	22	5.85	405	10.1	999
MW-204D	Loco. Shop Disp. Area B	DOB	129.84	35.3-45.3	94.5 - 84.5	BT	45.5	02/23/95	11	11.76	920	10.3	561
MW-204B	Loco. Shop Disp. Area B	BR	129.71	55.2-75.2	74.5 - 54.5	Granite	75.4	02/23/95	80	7.86	158	11.8	-10
MW-205S	Loco. Shop Disp. Area B	SOB	120.34	10.0-20.0	110.3 - 100.3	Outwash	20.4	02/16-17/95	248.3	6.60	854	9.5	14
MW-205D	Loco. Shop Disp. Area B	DOB	120.12	20.7-30.7	99.4 - 89.4	Outwash	31	02/16/95	318	6.47	635	9.9	215
MW-205B	Loco. Shop Disp. Area B	BR	120.3	34.3-54.3	86.0 - 66.0	Granite	54.7	02/16/95	108	6.98	229	12.6	15
MW-206S	Loco. Shop Disp. Area A	SOB	118.38	6.9-16.9	111.5 - 101.5	Outwash	17.2	02/23/95	55	7.71	722	10.2	111
MW-206D	Loco. Shop Disp. Area A	DOB	118.47	12.9-22.9	105.6 - 95.6	Outwash/AT	23.2	02/24/95	285	7.56	773	8.8	588
MW-206B	Loco. Shop Disp. Area A	BR	118.35	34.7-54.7	83.7 - 63.7	Granite	55.0	02/23/95	42	7.59	1,890	12.2	17
MW-207B	Contaminated Soil Area	BR	114.97	104.4-124.4	10.6 - (-9.4)	Granite	124.7	03/02/95	197	6.88	15,700	11.3	-10
MW-208S	Asbestos Lagoon	SOB	114.78	9.0-19.0	105.8 - 95.8	Outwash	20.0	02/07/95	150	6.40	170	8.8	230
MW-208D	Asbestos Lagoon	DOB	115.10	30.0-40.0	85.1 - 75.1	Outwash	44.0	02/08/95	333	5.86	335	10.5	10
MW-208B	Asbestos Lagoon	BR	115.08	64.0-84.0	51.1 - 31.1	Granite	84.0	02/08/95	140	6.38	422	10.6	6
MW-209B	Asbestos Lagoon	BR	114.36	44.8-64.8	69.6 - 49.6	Schist	65.0	02/09/95	90	6.20	609	12.3	-10
MW-210S	RSI Landfill	SOB	113.71	4.5-9.5	109.2 - 104.2	AT	10.0	02/14/95	22	6.20	563	3.8	158
MW-210B	RSI Landfill	BR	113.68	23.5-43.5	90.2 - 70.2	Granite	44.0	02/14/95	173	6.48	621	5.2	173
MW-211S	RSI Landfill	SOB	112.62	5.0-15.0	107.6 - 97.6	Outwash	15.4	02/13/95	301.8	6.31	953	3.6	14
MW-211D	RSI Landfill	DOB	112.41	15.6-25.6	96.8 - 86.8	Outwash	26.0	02/14/95	439	6.03	1,270	7.2	164
MW-211B	RSI Landfill	BR	112.50	27.4-47.4	85.1 - 65.1	Granite	47.8	02/14/95	83.5	6.92	542	10.3	-10
MW-212S	RSI Landfill	SOB	112.25	5.1-15.1	107.2 - 97.2	Outwash	15.5	02/10/95	103.4	8.04	505	5.7	24
MW-212D	RSI Landfill	DOB	112.35	14.7-24.7	97.7 - 87.7	Outwash/WBR	25	02/13/95	321	7.61	803	9.2	34
MW-212B	RSI Landfill	BR	112.31	31.8-51.8	80.5 - 60.5	Granite	52.1	02/10/95	1625	7.80	980	8.6	0

TABLE 3-2 (Continued). MONITORING WELL SPECIFICATIONS AND DEVELOPMENT DATA (1)

Well ID	Location	Formation Screened	Ground Elevation	Screened Interval (ft bgs)	Screened Elevation	Material Screened	Depth of Well (ft bgs)	Date Developed	Volume Removed (gallons)	Final pH	Final Conductivity (µmhos/cm)	Final Temp. (°C)	Final Turbidity (NTU)
MW-213S	B&M Landfill	SOB	113.33	7.4-17.4	105.9 - 95.9	Peat	17.7	02/22/95	18	7.35	1,430	9.0	860
MW-213D	B&M Landfill	DOB	113.54	41.3-51.3	72.2 - 62.2	Outwash	51.8	02/22/95	70	6.82	920	9.3	999
MW-213B	B&M Landfill	BR	113.20	64.1-84.1	49.1 - 29.1	Granite	91.0	02/22/95	42.5	7.76	492	7.7	999
MW-214S	B&M Landfill	SOB	110.83	15.1-25.1	95.7 - 85.7	Peat/Outwash	25.5	02/15/95	96.5	6.54	192	11.2	74
MW-214D	B&M Landfill	DOB	110.82	42.5-52.5	68.3 - 58.3	Outwash/WBR	53	02/15/95	345	6.10	386	8.3	0
MW-214B	B&M Landfill	BR	111.00	68.6-88.6	42.4 - 22.4	Granite	89	02/15/95	86	7.31	161	15.5	85
MW-215S	B&M Landfill	SOB	112.10	10.0-20.0	102.1 - 92.1	Outwash	20.5	02/15/95	422	6.21	163	8.6	0
MW-215D	B&M Landfill	DOB	111.90	39.6-49.6	72.3 - 62.3	Outwash	50	02/15/95	580	6.16	266	11.8	15
MW-215B	B&M Landfill	BR	112.18	66.1-86.1	46.1 - 26.1	Granite	86.7	02/15/95	80	6.9	180	17.0	30
PZ-101	Oil/Sludge Recycling	SOB	114.54	4.3-9.3	110.2 - 105.2	Clayey Fill	9.5	12/6/94	39	5.3	80	10.0	5
PZ-102	Oil/Sludge Recycling	SOB	121.21	8.8-13.8	112.4 - 107.4	Outwash	14.0	12/7/94	56	6.1	260	11.5	30
PZ-103	Oil/Sludge Recycling	SOB	115.17	4.8-9.8	110.4 - 105.4	Sandy Fill	10.3	12/6/94	196	6.51	309	11.6	34
PZ-104A	Loco. Shop Disp. Area A	SOB	118.49	9.5-14.5	109.0 - 104.0	Sandy Fill	14.7	12/6/94	307	6.59	448	12.7	2
PZ-105A	Loco. Shop Disp. Area A	SOB	117.39	9.4-14.6	108.0 - 102.8	Sandy Fill	14.6	12/6/94	378	6.94	544	12.6	0
PZ-106A	Loco. Shop Disp. Area A	SOB	115.25	4.8-10.1	110.5 - 105.2	Sandy Fill	10.1	12/6/94	224	6.91	1,160	10.7	4
PZ-104B	Loco. Shop Disp. Area B	SOB	123.92	9.4-14.4	114.5 -109.5	Outwash	15.0	12/6/94	48	6.7	470	11	0
PZ-105B	Loco. Shop Disp. Area B	SOB	119.51	9.0-14.0	110.5 - 105.5	Gravelly Fill	14.2	12/6/94	180	6.7	910	12	2
PZ-106B	Loco. Shop Disp. Area B	SOB	121.45	9.8-14.8	111.7 - 106.7	Outwash	15.0	12/6/94	150	6.7	690	12	0
PZ-107	Asbestos Lagoon	SOB	114.94	3.5-8.5	111.4 - 106.4	Sandy Fill	9.0	12/5/94	45	7.41	290	11.3	10
PZ-108	Asbestos Lagoon	SOB	114.66	4.3-9.3	110.4 - 105.4	Sandy Fill	9.5	12/5/94	28	7.0	470	10.0	9
PZ-109	Asbestos Lagoon	SOB	116.70	8.5-13.5	108.2 - 103.2	Sandy/Gravelly Fill	14.0	12/5/94	28	6.5	510	11.5	200
PZ-110	RSI Landfill	SOB	112.33	5.6-9.6	106.7 - 102.7	Sandy Fill	10.3	12/7/94	350	6.24	1,080	7.5	0
PZ-111	RSI Landfill	SOB	119.43	13.3-18.3	106.1 - 101.1	Sandy Fill/Outwash	18.6	12/7/94	565	6.5	690	13	10
PZ-112	RSI Landfill	SOB	124.27	14.0-19.0	110.3 - 105.3	Outwash	20.0	12/7/94	1.5	6.5	690	13	10
PZ-113	B&M Landfill	SOB	118.69	17.5-22.5	101.2 - 96.2	Outwash	25.0	12/7/94	225	6.56	1,340	7.7	999
PZ-114	B&M Landfill	SOB	114.20	13.6-18.6	100.6 - 95.6	Peat/Outwash	19.0	12/7/94	817	6.2	300	12	10
PZ-115	B&M Landfill	SOB	120.70	13.6-18.6	107.1 - 102.1	Sandy Fill	18.0	12/7/94	102	5.9	168	10.9	4

NOTES:
bgs = below ground surface
-- = Not applicable
SOB = Shallow Overburden
DOB = Deep Overburden
BR = Bedrock
WBR = Weathered Bedrock
AT = Ablation Till
BT = Basal Till

TABLE 3-3. STRATIGRAPHIC DATA OF MONITORING WELLS

Well ID	Ground Elevation (feet NGVD)	Fill		Peat (1)		Outwash		Ablation Till		Basal Till		Bedrock (2)		Weathered Bedrock	
		Depth (feet bgs)	Elevation (feet NGVD)	Depth (feet bgs)	Elevation (feet NGVD)	Depth (feet bgs)	Elevation (feet NGVD)	Depth (feet bgs)	Elevation (feet NGVD)	Depth (feet bgs)	Elevation (feet NGVD)	Depth (feet bgs)	Elevation (feet NGVD)	Depth (feet bgs)	Elevation (feet NGVD)
MW-200	131.42	(3)	--	--	--	1.0-2.0	130.42-129.42	2.0-15.5	129.42-115.92	15.0-25.0	115.92-106.42	25.0	106.42	25.0-40.0	106.42-96.42
MW-201	121.26	0-4.0	121.26-117.26	4.0-9.0	117.26-112.26	--	--	9.0-19.0	112.26-102.26	19.0-52.5	102.26-68.76	52.5	68.76	--	NA
MW-202	114.96	0-5.5	114.96-109.46	--	--	5.5-41.5	109.46-73.46	--	--	41.5-73.0	73.46-41.96	73.0	41.96	73.0-76.0	41.96-38.96
MW-203	115.41	0-6.0	115.41-109.41	6.0-9.0	109.41-106.41	9.0-42.0	106.41-73.41	--	--	42.0-48.5	73.41-66.91	48.5	66.91	--	NA
MW-204	129.71	0-11.0	129.71-118.71	--	--	--	--	11.0-25.0	118.71-104.71	25.0-45.0	104.71-84.71	45.0	84.71	--	NA
MW-205	120.34	0-9.0	120.34-111.34	--	--	9.0-30.0	111.34-90.34	--	--	--	--	30.0	90.34	30.0-31.0	90.34-89.34
MW-206	118.35	0-4.0	118.35-114.35	--	--	4.0-23.0	114.35-95.35	--	--	--	--	23.0	95.35	23.0-26.0	95.35-92.35
MW-207	114.97	--	--	0-6.0	114.97-108.97	6.0-62.0	108.97-52.97	--	--	62.0-85.0 (4)	52.97-29.97	85.0	29.97	--	NA
MW-208	115.08	0-4.0	115.08-111.08	4.0-7.0	111.08-108.08	7.0-46.0	108.08-69.08	46.0-57.5	69.08-57.58	--	--	57.5	57.58	--	NA
MW-209	114.36	--	--	--	--	0.0-37.0	114.36-77.36	--	--	--	--	37.0	77.36	37.0-41.0	77.36-73.36
MW-210	113.68	(3)	--	--	--	1.0-4.0	112.68-109.68	--	--	4.0-11.0	109.68-102.68	11.0	102.68	--	NA
MW-211	112.50	--	--	--	--	0.0-22.5	112.50-90.00	--	--	--	--	22.5	90.00	22.5-26.0	90.00-86.50
MW-212	112.31	--	--	--	--	0.0-22.5	112.31-89.81	--	--	--	--	22.5	89.81	22.5-35.5	89.81-76.81
MW-213	113.2	0-6.0	113.20-107.20	6.0-21.0	107.20-2.20	21.0-52.0	92.20-60.70	--	--	--	--	52.0	60.70	52.0-55.0	60.70-57.70
MW-214	111.0	0-6.0	111.00-105.00	6.0-24.0	105.00-87.00	24.0-53.0	87.00-58.00	--	--	--	--	53.0	58.00	53.0-61.0	58.00-50.00
MW-215	112.18	(3)	--	--	--	1.0-50.0	111.18-62.18	--	--	--	--	50.0	62.18	50.0-56.5	62.18-55.68

NOTES:

1. Peat or organic silt/sand
2. Elevation at top of unit
3. Topsoil and/or alluvium accounts for the upper one foot of stratigraphy at this location
4. Undifferentiated till at this location

--- Not encountered

bgs- below ground surface

NA - Not Applicable

NGVD - National Geodetic Vertical Datum

TABLE 3-4. GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS

Well ID	Formation Screened	Reference Elevation (ft NGVD)(5)	12/14/94 Depth to Water (ft below PVC)	12/14/94 Water Level Elevation (ft NGVD)	4/12/95 Depth to Water (ft below PVC)	4/12/95 Water Level Elevation (ft NGVD)	8/1/95 Depth to Water (ft below PVC)	8/1/95 Water Level Elevation (ft NGVD)
MONITORING WELLS (OW- AND MW-SERIES)								
OW-01	BR	113.52	4.03	109.49	4.37	109.15	4.69	108.83
OW-02	DOB	112.42	3.12	109.30	3.42	109.00	3.76	108.66
OW-03	SOB	113.19	3.91	109.28	4.25	108.94	4.57	108.62
OW-04	DOB	128.09	17.23	110.89	17.22	110.87	18.43	109.66
OW-05	BR	126.36	10.85	115.51	11.79	114.57	12.63	113.73
OW-06	DOB	126.54	10.05	116.49	11.43	115.11	(1)	(1)
OW-07	DOB	115.65	6.20	109.45	6.45	109.20	6.83	108.82
OW-08	SOB	115.69	6.24	109.45	6.47	109.22	6.85	108.84
OW-09	BR	116.33	5.50	110.83	6.09	110.24	6.54	109.79
OW-10	DOB	116.06	5.19	110.87	5.77	110.29	6.21	109.85
OW-11	SOB	116.20	5.32	110.88	5.91	110.29	6.34	109.86
OW-12	SOB	116.01	4.36	111.65	5.29	110.72	5.98	110.03
OW-13	DOB	120.02	8.77	111.25	9.35	110.67	9.80	110.22
OW-14	SOB	120.44	9.33	111.11	9.89	110.55	10.35	110.09
OW-15	DOB	116.95	5.72	111.23	6.35	110.6	6.78	110.17
OW-16	SOB	118.35	9.33	109.02	7.54	110.81	8.00	110.35
OW-17	BR	117.57	4.29	113.28	4.81	112.76	5.22	112.35
OW-18	DOB	116.15	2.98	113.17	3.50	112.65	3.91	112.24
OW-19	SOB	116.61	3.39	113.22	3.88	112.73	4.31	112.30
OW-20	DOB	116.87	5.78	111.09	6.46	110.41	6.86	110.01
OW-21	SOB	116.31	5.35	110.96	6.05	110.26	6.45	109.86
OW-22	BR	119.01	5.72	113.29	6.21	112.80	6.44	112.57
OW-23	DOB	118.72	5.44	113.28	5.90	112.82	6.10	112.62
OW-24	DOB	122.53	8.95	113.58	9.91	112.62	10.32	112.21
OW-25	DOB	117.24	4.57	112.67	5.49	111.75	5.81	111.43
OW-26	SOB	117.46	4.81	112.65	5.65	111.81	5.98	111.48
OW-27	SOB	117.09	4.46	112.63	5.33	111.76	5.61	111.48
OW-28	BR	117.76	4.84	112.92	5.65	112.11	6.01	111.75

TABLE 3-4 (Continued). GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS

Well ID	Formation Screened	Reference Elevation (ft NGVD)(5)	12/14/94 Depth to Water (ft below PVC)	12/14/94 Water Level Elevation (ft NGVD)	4/12/95 Depth to Water (ft below PVC)	4/12/95 Water Level Elevation (ft NGVD)	8/1/95 Depth to Water (ft below PVC)	8/1/95 Water Level Elevation (ft NGVD)
OW-29	DOB	117.92	5.18	112.74	5.94	111.98	6.30	111.62
OW-30	SOB	116.74	4.08	112.66	4.79	111.95	5.19	111.55
OW-31	SOB	117.84	5.11	112.73	5.89	111.95	6.24	111.6
OW-32	DOB	117.21	4.45(2)	112.76	4.71	112.5	5.14	112.07
OW-33	SOB	117.48	4.56(2)	112.92	4.94	112.54	5.34	112.14
OW-34	BR	114.08	3.87	110.21	4.46	109.62	4.85	109.23
OW-35	DOB	114.19	4.01	110.18	4.58	109.61	4.95	109.24
OW-36	SOB	113.85	3.76	110.09	4.33	109.52	4.66	109.19
OW-37	BR	117.32	3.74	113.58	4.69	112.63	5.02	112.30
OW-38	DOB	117.12	3.54	113.58	4.42	112.70	4.79	112.33
OW-39	DOB	118.00	4.12	113.88	4.79	113.21	5.14	112.86
OW-40	SOB	117.44	3.46	113.98	4.25	113.19	4.26	113.18
OW-41	DOB	118.12	4.68	113.44	5.32	112.80	5.81	112.31
OW-42	SOB	117.59	4.02	113.57	4.65	112.94	5.19	112.4
OW-43	SOB	118.45	4.19	114.26	4.80	113.65	5.37	113.08
OW-44	BR	115.01	3.24	111.77	4.13	110.88	4.78	110.23
OW-45	DOB	114.95	3.15	111.80	4.08	110.87	4.73	110.22
OW-46	SOB	114.56	2.66	111.90	3.60	110.96	4.31	110.25
OW-47	DOB	117.69	4.90	112.79	5.66	112.03	5.90	111.79
OW-48	SOB	117.58	4.55	113.03	5.39	112.19	5.67	111.91
OW-49	BR	112.48	3.86	108.62	4.35	108.13	4.92	107.56
OW-50	DOB	112.30	4.03	108.27	4.17	108.13	4.74	107.56
OW-51	SOB	112.02	3.68	108.34	4.00	108.02	4.66	107.36
MW-200B	BR	133.95	(4)	(4)	5.77	128.18	8.73	125.22
MW-200D	DOB	133.88	(4)	(4)	5.44	128.44	8.57	125.31
MW-200S	SOB	134.07	(4)	(4)	3.57	130.50	8.44	125.63
MW-201B	BR	123.24	(4)	(4)	8.48	114.76	9.72	113.52
MW-201D	DOB	123.41	(4)	(4)	8.65	114.76	10.67	112.74
MW-201S	SOB	122.64	(4)	(4)	8.23	114.41	10.10	112.54

TABLE 3-4 (Continued). GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS

Well ID	Formation Screened	Reference Elevation (ft NGVD)(5)	12/14/94 Depth to Water (ft below PVC)	12/14/94 Water Level Elevation (ft NGVD)	4/12/95 Depth to Water (ft below PVC)	4/12/95 Water Level Elevation (ft NGVD)	8/1/95 Depth to Water (ft below PVC)	8/1/95 Water Level Elevation (ft NGVD)
MW-202B	BR	117.31	(4)	(4)	4.61	112.70	5.03	112.28
MW-202D	DOB	117.46	(4)	(4)	5.05	112.41	5.43	112.03
MW-202S	SOB	117.70	(4)	(4)	5.23	112.47	5.66	112.04
MW-203B	BR	116.79	(4)	(4)	4.34	112.45	4.72	112.07
MW-203D	DOB	116.73	(4)	(4)	4.28	112.45	4.69	112.04
MW-203S	SOB	116.63	(4)	(4)	4.06	112.57	4.50	112.13
MW-204B	BR	132.20	(4)	(4)	16.67	115.53	17.39	114.81
MW-204D	DOB	132.48	(4)	(4)	14.30	118.18	16.53	115.95
MW-204S	SOB	132.39	(4)	(4)	13.77	118.62	16.14	116.25
MW-205B	BR	122.35	(4)	(4)	9.20	113.15	9.48	112.87
MW-205D	DOB	122.16	(4)	(4)	9.11	113.05	9.39	112.77
MW-205S	SOB	122.54	(4)	(4)	9.40	113.14	9.64	112.90
MW-206B	BR	120.76	(4)	(4)	8.16	112.60	8.32	112.44
MW-206D	DOB	121.10	(4)	(4)	8.56	112.54	8.70	112.40
MW-206S	SOB	120.85	(4)	(4)	8.29	112.56	8.42	112.43
MW-207	BR	116.63	(4)	(4)	5.22	111.41	5.56	111.07
MW-208B	BR	117.31	(4)	(4)	6.23	111.08	6.60	110.71
MW-208D	DOB	117.02	(4)	(4)	5.98	111.04	5.38	111.64
MW-208S	SOB	117.29	(4)	(4)	6.24	111.05	6.64	110.65
MW-209	BR	116.80	(4)	(4)	6.47	110.33	6.79	110.01
MW-210B	BR	116.24	(4)	(4)	6.25	109.99	6.71	109.53
MW-210S	SOB	115.89	(4)	(4)	5.99	109.90	6.28	109.61
MW-211B	BR	114.59	(4)	(4)	5.25	109.34	5.59	109.00
MW-211D	DOB	114.45	(4)	(4)	5.26	109.19	5.55	108.90
MW-211S	SOB	114.61	(4)	(4)	5.41	109.20	5.71	108.90
MW-212B	BR	114.61	(4)	(4)	5.30	109.31	5.64	108.97
MW-212D	DOB	114.18	(4)	(4)	4.87	109.31	5.19	108.99
MW-212S	SOB	114.28	(4)	(4)	4.97	109.31	5.29	108.99

TABLE 3-4 (Continued). GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS

			12/14/94		4/12/95		8/1/95	
Well ID	Formation Screened	Reference Elevation (ft NGVD)(5)	Depth to Water (ft below PVC)	Water Level Elevation (ft NGVD)	Depth to Water (ft below PVC)	Water Level Elevation (ft NGVD)	Depth to Water (ft below PVC)	Water Level Elevation (ft NGVD)
MW-213B	BR	114.97	(4)	(4)	6.37	108.6	6.73	108.24
MW-213D	DOB	115.84	(4)	(4)	7.27	108.57	7.62	108.22
MW-213S	SOB	115.63	(4)	(4)	7.19	108.44	7.62	108.01
MW-214B	BR	113.44	(4)	(4)	4.81	108.63	5.22	108.22
MW-214D	DOB	113.23	(4)	(4)	4.61	108.62	5.03	108.20
MW-214S	SOB	113.33	(4)	(4)	4.71	108.62	5.13	108.20
MW-215B	BR	114.16	(4)	(4)	5.26	108.90	5.72	108.44
MW-215D	DOB	113.86	(4)	(4)	4.98	108.88	5.42	108.44
MW-215S	SOB	114.28	(4)	(4)	5.40	108.88	5.84	108.44
PIEZOMETERS (P- AND PZ-SERIES)								
P-1	SOB	118.48	6.22	112.26	6.85	111.63	7.52	110.96
P-2	SOB	115.72	3.85	111.87	4.64	111.08	5.05	110.67
P-3	SOB	117.73	(3)	(3)	5.99	111.74	6.42	111.31
P-4	SOB	115.56	(3)	(3)	5.56	110.00	5.92	109.64
P-5	SOB	114.87	5.13	109.74	4.61	110.26	4.97	109.90
P-9	SOB	118.26	(3)	(3)	6.96	111.30	7.34	110.92
P-10	SOB	124.85	10.75	114.1	11.74	113.11	12.23	112.62
P-11	SOB	119.82	(3)	(3)	7.04	112.78	7.61	112.21
P-12	SOB	118.85	(3)	(3)	3.50	115.35	3.50	118.85
P-17	SOB	117.04	4.28	112.76	5.16	111.88	5.51	111.53
PZ-101	SOB	116.58	3.01	113.53	3.86	112.72	4.38	112.20
PZ-102	SOB	123.56	8.08	115.46	9.21	114.35	11.05	112.51
PZ-103	SOB	117.54	4.28	113.22	5.08	112.46	8.49	109.05
PZ-104A	SOB	121.02	7.89	113.29	8.16	112.86	8.41	112.61
PZ-105A	SOB	119.76	6.78	113.1	7.06	112.70	7.22	112.54
PZ-106A	SOB	117.59	4.81	113.02	5.04	112.55	5.19	112.40
PZ-104B	SOB	126.78	11.47	115.43	12.63	114.15	13.85	112.93
PZ-105B	SOB	122.26	8.92	113.52	9.26	113.00	9.60	112.66
PZ-106B	SOB	124.60	11.03	113.75	11.25	113.35	11.55	113.05
PZ-107	SOB	116.42	4.06	112.35	4.91	111.51	5.38	111.04
PZ-108	SOB	116.75	4.21	112.51	4.68	112.07	5.79	110.96
PZ-109	SOB	118.18	7.58	110.59	8.09	110.09	8.51	109.67
PZ-110	SOB	114.91	5.37	109.68	5.67	109.24	5.99	108.92
PZ-111	SOB	121.65	11.97	109.77	12.34	109.31	12.67	108.98
PZ-112	SOB	127.19	16.72	110.7	17.31	109.88	17.95	109.24
PZ-113	SOB	121.47	12.37	109.09	12.64	108.83	12.98	108.49

TABLE 3-4 (Continued). GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS

Well or Measuring Point ID	Formation Screened	Reference Elevation (ft NGVD)(5)	12/14/94		4/12/95		8/1/95	
			Depth to Water (ft below PVC)	Water Level Elevation (ft NGVD)	Depth to Water (ft below PVC)	Water Level Elevation (ft NGVD)	Depth to Water (ft below PVC)	Water Level Elevation (ft NGVD)
PZ-114	SOB	115.57	6.66	108.90	6.92	108.65	7.31	108.26
PZ-115	SOB	122.81	13.77	109.02	14.24	108.57	14.65	108.16
STAFF GAUGES AND SEEPAGE METERS								
SG-1	--	113.50	0.40	113.10	0.50	113.00	0.88	112.62
SG-2	--	108.49	1.40	107.09	1.99	106.50	2.54	105.95
SG-3	--	113.25	3.60	109.65	1.21	112.04	1.51	111.74
SG-4	--	112.83	0.80	112.03	3.70	109.13	2.78	110.05
SG-5	--	109.51	2.15	107.36	(1)	(1)	2.69	106.82
SG-6	--	111.01	1.40	109.61	1.55	109.46	1.75	109.26
SG-7	--	109.43	2.38	107.05	2.47	106.96	2.86	106.57
SG-8	--	108.80	2.00	106.80	0.81	107.99	1.36	107.44
SG-9	--	111.16	2.25	108.91	2.37	108.79	2.25	108.91
SG-10	--	111.86	(4)	(4)	1.71	110.15	1.80	110.06
SG-11	--	107.76	(4)	(4)	0.58	107.18	1.73	106.03
SG-12	--	114.13	(4)	(4)	1.46	112.67	1.79	112.34
SG-13	--	111.09	(4)	(4)	1.11	109.98	1.41	109.68
SG-14	--	112.74	(4)	(4)	1.22	111.52	1.55	111.19
SM-1	--	110.67	(4)	(4)	2.32	108.35	2.69	107.98
SM-2	--	110.12	(4)	(4)	1.91	108.21	2.15	107.97
SM-3	--	113.31	(4)	(4)	3.78	109.53	4.06	109.25
SM-4	--	113.73	(4)	(4)	3.99	109.74	4.41	109.32
SM-5	--	111.86	(4)	(4)	1.98	109.88	2.22	109.64
SM-6	--	111.93	(4)	(4)	2.18	109.75	2.52	109.41
SM-7	--	115.69	(4)	(4)	3.25	112.44	3.27	112.42
SM-8	--	115.53	(4)	(4)	3.28	112.25	3.19	112.34
SM-9	--	109.28	(4)	(4)	2.10	107.18	3.25	106.03

NOTES:
1. Well was dry on date of measurement
2. Measurement from top of steel
3. Well not measured
4. Not installed as of this date
5. Reference elevation from top of PVC pipe
-- Not applicable
NGVD – National Geodetic Vertical Datum of 1929

TABLE 3–5. STREAMBED CONDUCTIVITIES ESTIMATED FROM SEEPAGE METER DATA (1)

Seepage Meter	Depth to water (feet) (2)	Depth to water (feet) (3)	i	A (cc)	Time (minutes)	Volume (ml)	Water depth (ft)	Flow Rate (ml/min)	Flow Rate (cc/sec)	i*A	Q/i*A	Kv (ft/day)(4)	Kv (ft/day)(5)
SM–1	2.29	2.32	0.03	2107.60	4.70	125	1.70	26.60	0.44	63.23	0.00701	19.88	31.53
SM–2	1.81	1.91	0.10	2530.80	4.65	205	1.70	44.10	0.74	253.08	0.00290	8.23	16.40
SM–3	3.78	3.79	0.01	3010.80	10.22	265	0.73	25.90	0.43	30.11	0.01434	40.65	45.00
SM–4	3.80	3.99	0.19	3010.80	7.48	360	0.44	48.10	0.80	572.05	0.00140	3.97	4.60
SM–5	1.81	1.98	0.17	3010.80	3.48	120	1.15	34.48	0.57	511.84	0.00112	3.18	7.96
SM–6	2.01	2.18	0.17	3010.80	8.17	75	0.67	9.18	0.15	511.84	0.00030	0.85	2.32
SM–7	3.15	3.25	0.10	3010.80	51.88	105	0.36	2.02	0.03	301.08	0.00011	0.32	0.64
SM–8	3.06	3.28	0.22	3010.80	65.78	155	0.38	2.30	0.04	662.38	0.00006	0.16	0.33
SM–9	3.25	2.92	0.33	3010.80	119.00	545	1.80	4.58	0.08	993.56	0.00008	0.22	0.21

NOTES:

1. Data collected on April 12, 1995
2. Depth to surface water inside of streambed piezometer
3. Depth to groundwater as measured outside of streambed piezometer
4. Kv calculated using an assumed streambed thickness of 1.0 foot
5. Kv calculated using streambed thickness equal to stream bottom minus depth of streambed piezometer screen midpoint

TABLE 3-6. ESTIMATES OF HYDRAULIC CONDUCTIVITIES

Well ID	Area of Concern	Screened Material	Hydraulic Conductivity (Kh) (1) (cm/sec)	Hydraulic Conductivity (Kh) (1) (feet/day)	Geometric Mean (2) (cm/sec)	Geometric Mean (2) (feet/day)
MW-213S	B&M Railroad Landfill	Silty Peat	2.3E-03	6.25	**2.3E-03**	**6.25**
MW-203S	Old B&M Oil/Sludge Recycling Area	Peat/Outwash	6.5E-03	18.53		
MW-214S	B&M Railroad Landfill	Peat Outwash	8.2E-04	2.35	**2.3E-03**	**6.60**
MW-201S	Old B&M Oil/Sludge Recycling Area	Peat/Ablation Till	1.3E-02	38.47	**1.3E-02**	**38.47**
MW-202S	Old B&M Oil/Sludge Recycling Area	Outwash	8.3E-03	23.71		
MW-205S	B&M Loco. Shop Disposal Area B	Outwash	5.0E-03	14.12		
MW-206S	B&M Loco. Shop Disposal Area A	Outwash	2.9E-02	82.44		
MW-208S	Asbestos Lagoons	Outwash	(3)	(3)		
MW-211S	RSI Landfill	Outwash	1.4E-02	42.15		
MW-212S	RSI Landfill	Outwash	3.5E-02	99.60		
MW-215S	B&M Railroad Landfill	Outwash	1.1E-02	32.96		
MW-202D	Old B&M Oil/Sludge Recycling Area	Outwash	2.2E-02	62.40		
MW-203D	Old B&M Oil/Sludge Recycling Area	Outwash	4.9E-03	13.79		
MW-205D	B&M Loco. Shop Disposal Area B	Outwash	1.1E-02	29.48		
MW-208D	Asbestos Lagoons	Outwash	(3)	(3)		
MW-211D	RSI Landfill	Outwash	1.2E-02	34.32		
MW-213D	B&M Railroad Landfill	Outwash	1.6E-03	4.41		
MW-215D	B&M Railroad Landfill	Outwash	3.6E-03	10.10	**9.5E-03**	**26.97**
MW-206D	B&M Loco. Shop Disposal Area A	Outwash/Ablation Till	6.7E-02	187.48	**6.7E-02**	**187.48**
MW-200S	Background	Ablation Till	1.6E-03	4.71		
MW-204S	B&M Loco. Shop Disposal Area B	Ablation Till	9.8E-03	27.83		
MW-210S	RSI Landfill	Ablation Till	2.5E-03	7.12	**3.4E-03**	**9.77**
MW-204D	B&M Loco. Shop Disposal Area B	Basal Till	7.8E-06	0.02		
MW-200D	Background	Basal Till	2.1E-04	0.61		
MW-201D	Old B&M Oil/Sludge Recycling Area	Basal Till	4.2E-04	1.19	**8.8E-05**	**0.24**
MW-212D	RSI Landfill	Outwash/Weathered Bedrock	(3)	(3)		
MW-214D	Old B&M Oil/Sludge Recycling Area	Outwash/Weathered Bedrock	3.9E-03	11.08	**3.9E-03**	**11.08**

TABLE 3-6 (Continued). ESTIMATES OF HYDRAULIC CONDUCTIVITIES

Well ID	Area of Concern	Screened Material	Hydraulic Conductivity (Kh) (1) (cm/sec)	Hydraulic Conductivity (Kh) (1) (ft/day)	Geometric Mean (2) (cm/sec)	Geometric Mean (2) (ft/day)
MW-200B	Background	Bedrock	1.3E-04	0.37		
MW-201B	Old B&M Oil/Sludge Recycling Area	Bedrock	1.5E-03	4.45		
MW-202B	Old B&M Oil/Sludge Recycling Area	Bedrock	5.1E-05	0.14		
MW-203B	Old B&M Oil/Sludge Recycling Area	Bedrock	3.2E-05	0.10		
MW-204B	B&M Loco. Shop Disposal Area B	Bedrock	3.0E-04	0.88		
MW-205B	B&M Loco. Shop Disposal Area B	Bedrock	2.6E-04	0.73		
MW-206B	B&M Loco. Shop Disposal Area A	Bedrock	1.1E-04	0.31		
MW-207B	RSI Landfill	Bedrock	4.5E-04	1.27		
MW-208B	Asbestos Lagoons	Bedrock	3.1E-04	0.87		
MW-209B	Asbestos Lagoons	Bedrock	2.2E-04	0.65		
MW-210B	RSI Landfill	Bedrock	1.5E-05	0.05		
MW-211B	RSI Landfill	Bedrock	4.1E-05	0.12		
MW-212B	RSI Landfill	Bedrock	7.4E-03	20.89		
MW-213B	B&M Railroad Landfill	Bedrock	4.6E-05	0.13		
MW-214B	B&M Railroad Landfill	Bedrock	1.3E-04	0.35		
MW-215B	B&M Railroad Landfill	Bedrock	2.4E-05	0.07	**1.5E-04**	**0.42**

NOTES:
1. Values shown are the arithmetic averages of all slug test results from the well
2. Geometric mean is the mean of ln (Kh)
3. Well recovered too quickly during slug test to make a linear regression, used to calculate Kh

TABLE 3–7. ESTIMATES OF SEEPAGE VELOCITIES

Area of Concern	Seepage Velocities (feet/day)					
	April 1995			August 1995		
	Shallow Overburden	Deep Overburden	Bedrock	Shallow Overburden	Deep Overburden	Bedrock
B&M Railroad Landfill	0.0217	0.0195	0.0033	0.0178	0.0176	0.0027
RSI Landfill	0.2986	0.1535	0.0192	0.3359	0.1705	0.0202
B&M Locomotive Shop Disposal Areas						
Area A	0.1640	0.7600	0.0056	0.2050	0.8550	0.0062
Area B	0.2040	0.0346	0.0688	0.1261	0.0232	0.0624
Old B&M Oil/Sludge Recycling Area	0.0600	0.0909	0.0020	0.0360	0.0370	0.0023
Asbestos Lagoons	0.1337	0.2019	0.0340	0.1449	0.6506	0.0323

NOTES:

1. Seepage velocity = hydraulic conductivity (Kh) * hydraulic gradient (dh/dl)/porosity (n)
2. Porosity values for each area determined from laboratory geotechnical analyses
3. Porosity value used for bedrock (5%) is from Domenico and Schwartz (1990)

TABLE 3-8. SUMMARY OF HORIZONTAL HYDRAULIC GRADIENTS

	Horizontal Hydraulic Gradients (feet/feet)					
	April 1995			August 1995		
Area of Concern	Shallow Overburden	Deep Overburden	Bedrock	Shallow Overburden	Deep Overburden	Bedrock
B&M Railroad Landfill	0.001	0.001	0.001	0.001	0.001	0.001
RSI Landfill	0.002	0.002	0.002	0.003	0.002	0.002
B&M Locomotive Shop Disposal Areas						
Area A	0.001	0.001	0.001	0.001	0.001	0.001
Area B	0.009	0.009	0.004	0.006	0.006	0.004
Old B&M Oil/Sludge Recycling Area	0.002	0.003	0.002	0.001	0.001	0.002
Asbestos Lagoons	0.001	0.001	0.002	0.001	0.003	0.002

TABLE 3-9. VERTICAL GRADIENTS AT MONITORING WELL CLUSTERS

Well ID	Formations Screened	12/14/94 Water Level Elevations (ft NGVD)	12/14/94 Direction of Vertical Gradient (1)	4/12/95 Water Level Elevations (ft NGVD)	4/12/95 Direction of Vertical Gradient (1)	8/1/95 Water Level Elevations (ft NGVD)	8/1/95 Direction of Vertical Gradient (1)
OW-01/OW-02	BR/DOB	109.49/109.30	up	109.15/109.00	up	108.83/108.66	up
OW-02/OW-03	DOB/SOB	109.30/109.28	up	109.00/108.94	up	108.66/108.62	up
OW-05/OW-06	BR/DOB	115.51/116.49	down	114.57/115.11	down	113.73/(2)	N/A
OW-07/OW-08	DOB/SOB	109.45/109.45	neutral	109.20/109.22	neutral	108.82/108.84	neutral
OW-09/OW-10	BR/DOB	110.83/110.87	down	110.24/110.29	down	109.79/109.85	down
OW-10/OW-11	DOB/SOB	110.87/110.88	neutral	110.29/110.29	neutral	109.85/109.86	neutral
OW-11/OW-12	SOB/SOB	110.88/111.65	up	110.29/110.72	down	109.86/110.03	down
OW-13/OW-14	DOB/SOB	111.25/111.11	up	110.67/110.55	up	110.22/110.09	up
OW-15/OW-16	DOB/SOB	111.23/109.02	up	110.6/110.81	down	110.17/110.35	down
OW-17/OW-18	BR/DOB	113.28/113.17	up	112.76/112.65	up	112.35/112.24	up
OW-18/OW-19	DOB/SOB	113.17/113.22	down	112.65/112.73	down	112.24/112.30	down
MW-209/OW-20	BR/DOB	(3)	N/A	110.33/110.41	down	110.01/110.01	neutral
OW-20/OW-21	DOB/SOB	111.09/110.96	up	110.41/110.26	up	110.01/109.86	up
OW-22/OW-23	BR/DOB	113.29/113.28	neutral	112.80/112.82	neutral	112.57/112.62	down
MW-207/OW-26	BR/DOB	(3)	N/A	111.41/111.75	down	111.07/111.43	down
OW-25/OW-26	DOB/SOB	112.67/112.65	neutral	111.75/111.81	down	111.43/111.48	down
OW-26/OW-27	SOB/SOB	112.65/112.63	neutral	111.81/111.76	up	111.48/111.48	neutral
OW-28/OW-29	BR/DOB	112.92/112.74	up	112.11/111.98	up	111.75/111.62	up
OW-29/OW-30	DOB/SOB	112.74/112.66	up	111.98/111.95	up	111.62/111.55	up
OW-30/OW-31	SOB/SOB	112.66/112.73	down	111.95/111.95	neutral	111.55/111.60	down
OW-32/OW-33	DOB/SOB	112.76/112.92	up	112.5/112.54	down	112.07/112.14	down
OW-34/OW-35	BR/DOB	110.21/110.81	up	109.62/109.61	neutral	109.23/109.24	neutral
OW-35/OW-36	DOB/SOB	110.18/110.09	up	109.61/109.52	up	109.24/109.19	up
OW-37/OW-38	BR/DOB	113.58/113.58	neutral	112.63/112.70	down	112.30/112.33	down

TABLE 3-9 (Continued). VERTICAL GRADIENTS AT MONITORING WELL CLUSTERS

Well ID	Formations Screened	12/14/94 Water Level Elevations (ft NGVD)	12/14/94 Direction of Vertical Gradient (1)	4/12/95 Water Level Elevations (ft NGVD)	4/12/95 Direction of Vertical Gradient (1)	8/1/95 Water Level Elevations (ft NGVD)	8/1/95 Direction of Vertical Gradient (1)
OW-39/OW-40	DOB/SOB	113.88/113.98	down	113.21/113.19	up	112.86/113.18	down
OW-41/OW-42	DOB/SOB	113.44/113.57	down	112.80/112.94	down	112.31/112.40	down
OW-42/OW-43	SOB/SOB	113.57/114.26	up	112.94/113.65	up	112.40/113.08	up
OW-44/OW-45	BR/DOB	111.77/111.80	down	110.88/110.87	neutral	110.23/110.22	neutral
OW-45/OW-46	DOB/SOB	111.80/111.90	down	110.87/110.96	down	110.22/110.25	down
OW-47/OW-48	DOB/SOB	112.79/113.03	up	112.03/112.19	down	111.79/111.91	down
OW-49/OW-50	BR/DOB	108.62/108.27	up	108.13/108.13	neutral	107.56/107.56	neutral
OW-50/OW-51	DOB/SOB	108.27/108.34	down	108.13/108.02	up	107.56/107.36	up
MW-200B/MW-200D	BR/DOB	(3)	N/A	128.18/128.44	down	125.22/125.31	down
MW-200D/MW-200S	DOB/SOB	(3)	N/A	128.44/130.50	down	125.31/125.63	down
MW-201B/MW-201D	BR/DOB	(3)	N/A	114.76/114.76	neutral	113.52/112.74	up
MW-201D/MW-201S	DOB/SOB	(3)	N/A	114.76/114.41	up	112.74/112.54	up
MW-202B/MW-202D	BR/DOB	(3)	N/A	112.70/112.41	up	112.28/112.03	up
MW-202D/MW-202S	DOB/SOB	(3)	N/A	112.41/112.47	down	112.03/112.04	neutral
MW-203B/MW-203D	BR/DOB	(3)	N/A	112.45/112.45	neutral	112.07/112.04	neutral
MW-203D/MW-203S	DOB/SOB	(3)	N/A	112.45/112.57	down	112.04/112.13	down
MW-204B/MW-204D	BR/DOB	(3)	N/A	115.53/118.18	down	114.81/115.95	down
MW-204D/MW-204S	DOB/SOB	(3)	N/A	118.18/118.62	down	115.95/116.25	down
MW-205B/MW-205D	BR/DOB	(3)	N/A	113.15/113.05	up	112.87/112.77	up
MW-205D/MW-205S	DOB/SOB	(3)	N/A	113.05/113.14	down	112.77/112.90	down
MW-206B/MW-206D	BR/DOB	(3)	N/A	112.60/112.54	up	112.44/112.40	up
MW-206D/MW-206S	DOB/SOB	(3)	N/A	112.54/112.56	neutral	112.40/112.43	neutral
MW-208B/MW-208D	BR/DOB	(3)	N/A	111.08/111.04	up	110.71/110.64	up
MW-208D/MW-208S	DOB/SOB	(3)	N/A	111.04/111.05	neutral	111.64/110.65	neutral
MW-210B/MW-210S	BR/SOB	(3)	N/A	109.99/109.90	up	109.53/109.61	down

TABLE 3-9 (Continued). VERTICAL GRADIENTS AT MONITORING WELL CLUSTERS

Well ID	Formations Screened	12/14/94		4/12/95		8/1/95	
		Water Level Elevations (ft NGVD)	Direction of Vertical Gradient (1)	Water Level Elevations (ft NGVD)	Direction of Vertical Gradient (1)	Water Level Elevations (ft NGVD)	Direction of Vertical Gradient (1)
MW-211B/MW-211D	BR/DOB	(3)	N/A	109.34/109.19	up	109.00/108.90	up
MW-211D/MW-211S	DOB/SOB	(3)	N/A	109.19/109.20	neutral	108.90/108.90	neutral
MW-212B/MW-212D	BR/DOB	(3)	N/A	109.31/109.31	neutral	108.97/108.99	neutral
MW-212D/MW-212S	DOB/SOB	(3)	N/A	109.31/109.31	neutral	108.99/108.99	neutral
MW-213B/MW-213D	BR/DOB	(3)	N/A	108.60/108.57	neutral	108.24/108.22	neutral
MW-213D/MW-213S	DOB/SOB	(3)	N/A	108.57/108.44	up	108.22/108.01	up
MW-214B/MW-214D	BR/DOB	(3)	N/A	108.63/108.62	neutral	108.22/108.20	neutral
MW-214D/MW-214S	DOB/SOB	(3)	N/A	108.62/108.62	neutral	108.20/108.20	neutral

NOTES:

N/A = Not applicable

1. Groundwater elevations within 0.0 to 0.03 feet of each other were considered to have a neutral vertical gradient
2. Well was dry on date of measurement
3. Not installed as of this date

TABLE 3-10. SUMMARY OF HYDROGEOLOGICAL DATA

Area of Concern	Groundwater Flow Direction	Potential for Discharge to Surface Water?	Adjacent Surface Water	Kh (avg) (feet/day)	Hydraulic Gradient (avg) (feet/feet) *	Seepage Velocity (avg) (feet/day) *
B&M Railroad Landfill						
Shallow overburden	E/NE	yes	B&M Pond/Middlesex Canal	7.9	0.001	0.0198
Deep overburden	E/NE	yes	B&M Pond/Middlesex Canal	7.7	0.001	0.0186
Bedrock	E/NE	yes	B&M Pond/Middlesex Canal	0.15	0.001	0.0030
RSI Landfill						
Shallow overburden	NE	yes/no	Unnamed Stream	31.08	0.003	0.3173
Deep overburden	NE	yes/no	Unnamed Stream	34.10	0.002	0.1620
Bedrock	NE	yes/no	Unnamed Stream	0.48	0.002	0.0197
B&M Locomotive Shop Disposal Area A						
Shallow overburden	NE	yes	Unnamed Stream	82	0.001	0.1845
Deep overburden	NE	yes	Unnamed Stream	190	0.001	0.8075
Bedrock	NE	yes	Unnamed Stream	0.31	0.001	0.0059
B&M Locomotive Shop Disposal Area B						
Shallow overburden	NE	yes	Unnamed Stream	9.17	0.006	0.1020
Deep overburden	NE	yes	Unnamed Stream	0.76	0.008	0.0289
Bedrock	NE	yes	Unnamed Stream	0.80	0.004	0.0656
Old B&M Oil/Sludge Recycling Area						
Shallow overburden	N/NE	NA	none	12.02	0.001	0.0480
Deep overburden	E	NA	none	10.14	0.002	0.0640
Bedrock	NE	NA	none	0.06	0.002	0.0122
Asbestos Lagoons						
Shallow overburden	NW & NE	yes	Middlesex Canal	39	0.001	0.1393
Deep overburden	NW & NE	yes	Middlesex Canal	34.1	0.002	0.4263
Bedrock	NW & NE	yes	Middlesex Canal	0.48	0.002	0.0332

NOTES:

Kh – Hydraulic Conductivity

NA – Not Applicable

* Hydraulic gradient and seepage velocity were obtained using 4/95 and 8/95 data.

TABLE 4-1. SUMMARY OF ANALYTES DETECTED IN SURFACE SOIL SAMPLES FROM BACKGROUND LOCATIONS (1)

	Range of SQLs (2)		Sampling Locations (3)		
	Minimum	Maximum	SS-11 (0-1 ft)	SS-12 (0-1 ft)	SS-13 (0-1 ft)
Volatile Organics (μg/kg)					
Methylene Chloride	11 -	12	36	7 J	9 J
Semivolatile Organics (μg/kg)					
None Detectedd					
Pesticides (μg/kg)					
Heptachlor Epoxide	1.8 -	2.0	--	2.0 J	0.62 J
Dieldrin	3.5 -	3.9	--	2.1 J	--
4,4'-DDE	3.5 -	3.9	4.9 J	2.4 J	1.6 J
Endosulfan II	3.5 -	3.9	1.0 J	--	0.60 J
4,4'-DDD	3.5 -	3.9	2.6 J	1.3 J	2.2 J
4,4'-DDT	3.5 -	3.9	7.7 J	5.8	2.9 J
Methoxychlor	18 -	20	1.8 J	--	--
alpha-Chlordane	1.8 -	2.0	--	0.27 J	--
PCBs (μg/kg)					
None Detected					
Metals (mg/kg)					
Aluminum	9.2 -	10	8,660 J	9,630 J	5,350 J
Arsenic	0.9 -	1.0	7.6 J	5.5 J	4.0 J
Barium	0.4 -	0.5	32.0	13.5	9.3
Calcium	24.3 -	26.	949	--	--
Copper	3.3 -	3.6	8.9 J	5.1 J	4.7 J
Iron	2.9 -	3.1	8,350	7,030	4,640
Lead	5.5 -	6.0	102	--	--
Magnesium	80.7 -	88.0	1,480	754	687
Manganese	0.9 -	1.0	206 J	32.0 J	187 J
Vanadium	2.2 -	2.4	13.7	12.9	7.2
Zinc	1.1 -	1.2	46.6 J	18.4 J	--
Soil Quality Parameters (mg/kg)					
Cyanide - None Detected					
Total Petroleum Hydrocarbons - None Detected					
Geotechnical Parameters (%)					
Total Combustible Organics - Not Analyzed					
Soil Moisture Content - Not Analyzed					

NOTES:
1. Analytical data are presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. All samples were collected as discrete samples.
4. Although data are presented, detailed review of laboratory reports indicates that it is a laboratory artifact.
-- - Analyte was not detected in this sample
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-2. BACKGROUND METAL CONCENTRATIONS IN SURFICIAL SOILS IN THE EASTERN U.S., AND MASSACHUSETTS

	EASTERN UNITED STATES (1)		
	ARITHMETIC AVERAGE (mg/kg)	RANGE (mg/kg)	MASSACHUSETTS(2) (mg/kg)
Aluminum	5.7	700 to > 10,000	33,000
Iron	25,000	100 to > 100,000	15,000
Calcium	6,300	100 to 280,000	10,700
Magnesium	4,600	50 to > 50,000	7,000
Potassium	15,000	50 to 37,000	18,300
Sodium	7,800	< 500 to 50,000	10,000
Barium	420	10 to 1,500	300
Beryllium	0.85	< 1 to 7	1.0
Antimony	0.76	< 1 to 8.8	--
Arsenic	7.4	0.1 to 73	7.9
Cadmium	--	--	--
Chromium	52	1 to 1,000	30.0
Cobalt	9.2	< 0.3 to 70	7.0
Copper	22	< 1 to 700	15.0
Lead	17	< 10 to 300	15.0
Manganese	640	< 2 to 7,000	700
Mercury	0.12	0.01 to 3.4	0.18
Nickel	18	< 5 to 700	15
Selenium	0.45	< 0.1 to 3.9	0.3
Silver	--	--	--
Thallium	8.6	2.2 to 23	--
Vanadium	66	< 7 to 300	70.0
Zinc	52	< 5 to 2,900	440,000

NOTES:

1. Boerngen and Shacklette (1981)
2. Shacklette and Boerngen (1984); data presented for one sample. The sample was collected from Middlesex, MA along interstate 90 at interchange 13.

-- - No data available

TABLE 4-3. SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM B&M RAILROAD LANDFILL (1)

Analyte	Range of SQLs (2) Minimum	Range of SQLs (2) Maximum	Background Surface Soil Range of Values (4) Minimum	Background Surface Soil Range of Values (4) Maximum	Surface Soil Frequency of Detection (3)	Surface Soil Arithmetic Average	Surface Soil Range of Values (4) Minimum	Surface Soil Range of Values (4) Maximum	Surface Soil Maximum Location	Borehole Soil Frequency of Detection (3)	Borehole Soil Arithmetic Average	Borehole Soil Range of Values (4) Minimum	Borehole Soil Range of Values (4) Maximum	Borehole Soil Maximum Location	Borehole Soil Depth Interval (feet)	Test Pit Soil Frequency of Detection (3)	Test Pit Soil Arithmetic Average	Test Pit Soil Range of Values (4) Minimum	Test Pit Soil Range of Values (4) Maximum	Test Pit Soil Maximum Location	Test Pit Soil Depth Interval (feet)
Volatile Organics (µg/kg)																					
Toluene	10	6,300	--	--	0 / 14	--	--	--	--	5 / 27	39	1 J	870 J	BH-10	8 - 10	2 / 14	8 *	1 J	3 J	TP-09	3.5 - 4.5
Styrene	10	6,300	--	--	0 / 14	--	--	--	--	1 / 27	120 *	1 J		BH-02	5 - 7	1 / 14	8 *	5 J		TP-04	5.0 - 5.2
Acetone (5)	10	6,300	--	--	5 / 14	15	7 J	42	SS-70	2 / 27	510	500	13,000	BH-10	8 - 10	3 / 14	56	17 J	57	TP-11	5.0 - 6.0
2-Butanone (5)	10	6,300	--	--	1 / 14	6	7 J		SS-74	2 / 27	120 *	5 J	10 J	BH-10	6 - 8	9 / 14	18	4 J	69	TP-06	9.0 - 9.2
4-Methyl-2-pentanone	10	6,300	--	--	0 / 14	--	--	--	--	0 / 27	--	--	--	--	--	2 / 14	9	3 J	20 J	TP-04	5.0 - 5.2
1,1,1-Trichloroethane	10	6,300	--	--	0 / 14	--	--	--	--	1 / 27	120 *	2 J		BH-01	2 - 4	0 / 14	--	--	--	--	--
Methylene Chloride (5)	10	6,300	7 J	36	8 / 14	94	21	280 J	SS-70	0 / 27	--	--	--	--	--	0 / 14	--	--	--	--	--
Chloromethane	10	6,300	--	--	0 / 14	--	--	--	--	0 / 27	--	--	--	--	--	2 / 14	8 *	2 J	3 J	TP-12	1.5 - 2.0
Carbon Disulfide	10	6,300	--	--	0 / 14	--	--	--	--	2 / 27	120 *	1 J	8 J	BH-02	7 - 9	1 / 14	8 *	4 J		TP-08	1.0 - 2.0
Ethylbenzene	10	6,300	--	--	0 / 14	--	--	--	--	1 / 27	120 *	2 J		BH-02	5 - 7	2 / 14	10	3 J	31.5 J	TP-04	5.0 - 5.2
Total Xylenes	10	6,300	--	--	0 / 14	--	--	--	--	3 / 27	130 *	4 J	120	BH-02	7 - 9	1 / 14	10	37		TP-04	5.0 - 5.2
Semivolatile Organics (µg/kg)																					
Naphthalene	340	69,000	--	--	6 / 14	1,700 *	100 J	280 J	SS-72	4 / 22	3,600	83 J	7,400	BH-11	4 - 6	7 / 14	5,100	52 J	11,000 J	TP-08	1.0 - 2.0
2-Methylnaphthalene	340	69,000	--	--	7 / 14	1,700 *	130 J	260 J	SS-71	13 / 22	2,900	130 J	5,400	BH-11	4 - 6	7 / 14	4,400 *	42 J	2,300 J	TP-08	1.0 - 2.0
Acenaphthylene	340	69,000	--	--	11 / 14	1,700	230 J	3,200 J	SS-69	7 / 22	3,000 *	67 J	660 J	BH-11	4 - 6	0 / 14	--	--	--	--	--
Acenaphthene	340	69,000	--	--	5 / 14	1,700 *	96 J	340 J	SS-71	9 / 22	3,000	52 J	5,700	BH-11	4 - 6	4 / 14	4,600	290 J	6,200 J	TP-08	1.0 - 2.0
Fluorene	340	69,000	--	--	5 / 14	1,700 *	97 J	340 J	SS-71	10 / 22	3,200	150 J	6,200	BH-11	4 - 6	5 / 14	4,300	290 J	6,100 J	TP-08	1.0 - 2.0
Phenanthrene	340	69,000	--	--	14 / 14	2,500	240 J	17,000 J	SS-61	19 / 22	3,700	160 J	16,000	BH-11	4 - 6	10 / 14	4,900	61 J	11,000 J	TP-10	2.0 - 2.5
Anthracene	340	69,000	--	--	12 / 14	1,900	140 J	5,800 J	SS-61	9 / 22	3,000	66 J	4,500 J	BH-11	4 - 6	5 / 14	4,400 *	45 J	2,300 J	TP-08	1.0 - 2.0
Fluoranthene	340	69,000	--	--	14 / 14	6,100	460	28,000 J	SS-61	21 / 22	4,300	180 J	14,000 J	BH-14	4 - 8	11 / 14	4,300	83 J	12,000 J	TP-08	1.0 - 2.0
Pyrene	340	69,000	--	--	14 / 14	6,300	410	24,000 J	SS-61	20 / 22	4,800	39 J	13,000 J	BH-02	5 - 11	11 / 14	5,900	55 J	15,000 J	TP-10	2.0 - 2.5
Benzo(a)anthracene	340	69,000	--	--	14 / 14	3,500	260 J	16,000 J	SS-61	18 / 22	3,000	120 J	5,000 J	BH-14	4 - 8	9 / 14	4,400 *	41 J	3,400 J	TP-10	2.0 - 2.5
Chrysene	340	69,000	--	--	14 / 14	4,000	380	20,000 J	SS-61	21 / 22	2,400	57 J	5,900 J	BH-14	4 - 8	10 / 14	3,500	61 J	4,400 J	TP-07	4.0 - 4.2
Benzo(b)fluoranthene	340	69,000	--	--	14 / 14	8,200	520	33,000 J	SS-61	20 / 22	2,600	50 J	6,000 J	BH-11	4 - 6	9 / 14	4,300 *	48 J	2,800 J	TP-10	2.0 - 2.5
Benzo(k)fluoranthene	340	69,000	--	--	0 / 14	--	--	--	--	20 / 22	2,900	49 J	10,000 J	BH-05	6 - 8	8 / 14	4,800 *	55 J	3,800 J	TP-08	1.0 - 2.0
Benzo(a)pyrene	340	69,000	--	--	14 / 14	3,600	200 J	18,000 J	SS-61	19 / 22	2,100	410 J	4,300 J	BH-04	0 - 4	9 / 14	4,300 *	49 J	2,600 J	TP-10	1.0 - 2.0
Dibenz(a,h)anthracene	340	69,000	--	--	7 / 14	1,600	90 J	4,200 J	SS-61	11 / 22	2,700 *	330 J	1,500 J	BH-11	4 - 6	3 / 14	4,500 *	69 J	1,300 J	TP-11	5.0 - 6.0
Benzo(g,h,i)perylene	340	69,000	--	--	12 / 14	1,900	110 J	10,000 J	SS-61	14 / 22	1,800	380 J	2,400 J	BH-04	0 - 4	5 / 14	4,800 *	71 J	3,300 J	TP-11	5.0 - 6.0
Indeno(1,2,3-cd)pyrene	340	69,000	--	--	13 / 14	2,000	110 J	10,000 J	SS-61	13 / 22	2,600	330 J	2,900 J	BH-04	0 - 4	6 / 14	4,600 *	45 J	2,200 J	TP-11	5.0 - 6.0
Isophorone	340	69,000	--	--	1 / 14	1,700 *	430 J		SS-65	0 / 22	--	--	--	--	--	0 / 14	--	--	--	--	--
3-Nitroaniline	820	170,000	--	--	0 / 14	--	--	--	--	0 / 22	--	--	--	--	--	1 / 14	12,000 *	9,900 J		TP-06	9.0 - 9.2
Dibenzofuran	340	69,000	--	--	5 / 14	1,700 *	130 J	290 J	SS-71	12 / 22	2,900	100 J	4,600 J	BH-11	4 - 6	6 / 14	4,500	41 J	4,600 J	TP-08	1.0 - 2.0
Phenol	340	69,000	--	--	3 / 14	1,700 *	110 J	200 J	SS-68	0 / 22	--	--	--	--	--	1 / 14	4,800 *	870 J		TP-06	9.0 - 9.2
2-Methylphenol	340	69,000	--	--	0 / 14	--	--	--	--	1 / 22	3,100 *	89 J		BH-12	2 - 4	0 / 14	--	--	--	--	--
4-Methylphenol	340	69,000	--	--	2 / 14	1,700 *	90 J	96 J	SS-64	2 / 22	2,900 *	180 J	1,900 J	BH-13	4 - 6	2 / 14	3,900	3,900 J	4,200	TP-06	9.0 - 9.2
2,4-Dimethylphenol	340	69,000	--	--	0 / 14	--	--	--	--	1 / 22	3,100 *	65 J	65 J	BH-12	2 - 4	0 / 14	--	--	--	--	--
Di-n-butylphthalate	340	69,000	--	--	1 / 14	1,700 *	390 J		SS-65	0 / 22	--	--	--	--	--	5 / 14	2,900	230 J	8,800 J	TP-07	4.0 - 4.2
Bis(2-ethylhexyl)phthalate	340	69,000	--	--	7 / 14	3,700	36 J	25,000 J	SS-65	10 / 22	21,000	690	190,000 J	BH-07	2 - 6	7 / 14	60,000	600 J	260,000	TP-04	5.0 - 5.2
Di-n-octylphthalate	340	69,000	--	--	0 / 14	--	--	--	--	5 / 22	2,900	240 J	6,300 J	BH-07	0 - 2	3 / 14	3,900	5,700 J	18,000 J	TP-07	4.0 - 4.2
Butylbenzylphthalate	340	69,000	--	--	5 / 14	2,900	1,400	10,000 J	SS-71	17 / 22	8,100	120 J	28,000 J	BH-13	0 - 2	9 / 14	7,600	36 J	38,000 J	TP-07	4.0 - 4.2
Bis(2-chloroethyl)ether	340	69,000	--	--	1 / 14	1,700 *	280 J		SS-72	0 / 22	--	--	--	--	--	0 / 14	--	--	--	--	--
Carbazole	340	69,000		--	8 / 14	1,500	90 J	3,400 J	SS-61	6 / 22	2,800 *	200 J	1,200 J	BH-14	4 - 8	3 / 14	4,400 *	180 J	1,600 J	TP-08	1.0 - 2.0
Pesticides (µg/kg)																					
alpha-BHC	1.8	28	--	--	5 / 13	1.3	1.1 J	2.5 J	SS-72	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--
beta-BHC	1.8	28	--	--	1 / 14	0.95	1.1 J		SS-61	1 / 21	7.5 *	2.0 J		BH-01	0 - 2	0 / 14	--	--	--	--	--
delta-BHC	1.8	28	--	--	2 / 13	0.99	1.1 J	1.4 J	SS-70	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--
gamma-BHC(Lindane)	1.8	28	--	--	8 / 14	0.82	0.18 J	1.8 J	SS-61	7 / 22	8.4	2.2 J	21 J	BH-09	0 - 2	0 / 14	--	--	--	--	--
4,4'-DDE	3.4	54	1.6 J	4.9 J	10 / 14	14	5.2 J	50 J	SS-69	2 / 21	19	6.0 J	120 J	BH-13	4 - 6	0 / 14	--	--	--	--	--
4,4'-DDD	3.4	54	1.3 J	2.6 J	14 / 14	28	5.9 J	97 J	SS-69	4 / 21	19	11 J	60 J	BH-14	4 - 8	1 / 14	16	71 J		TP-06	9.0 - 9.2
4,4'-DDT	3.4	54	2.9 J	7.7 J	13 / 14	62	11 J	230 J	SS-69	3 / 21	17	9.6 J	44 J	BH-13	4 - 6	0 / 14	--	--	--	--	--
Methoxychlor	18	280	1.8 J		10 / 13	66	22 J	170 J	SS-69	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--
Heptachlor	1.8	28	--	--	3 / 13	0.84 *	0.46 J	0.59 J	SS-69	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--
Heptachlor Epoxide	1.8	28	0.62 J	2.0 J	14 / 14	3.9	0.69 J	9.7 J	SS-72	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--
Endosulfan I	1.8	28	--	--	2 / 13	1.00	0.85 J	1.9 J	SS-69	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--
Endosulfan II	3.4	54	0.6 J	1.0 J	5 / 13	6.2	3.4 J	23 J	SS-65	5 / 21	47	57 J	220 J	BH-07	2 - 6	0 / 14	--	--	--	--	--
Endosulfan Sulfate	3.4	54	--	--	7 / 13	20	5.8 J	79 J	SS-73	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--
Aldrin	1.8	28	--	--	7 / 14	1.6	0.98 J	3.9 J	SS-69	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--

TABLE 4-3 (Continued). SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM B&M RAILROAD LANDFILL (1)

Analyte	Range of SQLs (2) Minimum	Range of SQLs (2) Maximum	Background Surface Soil Range of Values (4) Minimum	Background Surface Soil Range of Values (4) Maximum	Surface Soil Frequency of Detection (3)	Surface Soil Arithmetic Average	Surface Soil Range of Values (4) Minimum	Surface Soil Range of Values (4) Maximum	Surface Soil Maximum Location	Borehole Soil Frequency of Detection (3)	Borehole Soil Arithmetic Average	Borehole Soil Range of Values (4) Minimum	Borehole Soil Range of Values (4) Maximum	Borehole Soil Maximum Location	Borehole Soil Depth Interval (feet)	Test Pit Soil Frequency of Detection (3)	Test Pit Soil Arithmetic Average	Test Pit Soil Range of Values (4) Minimum	Test Pit Soil Range of Values (4) Maximum	Test Pit Soil Maximum Location	Test Pit Soil Depth Interval (feet)
Pesticides (continued) (µg/kg)																					
Dieldrin	3.4	54	2.1 J		1 / 13	3.1	5.2 J		SS-62	11 / 21	54	5.3 J	180 J	BH-09	0 - 2	0 / 14	--	--	--	--	--
Endrin	3.4	54	--	--	11 / 13	56	3.0 J	140 J	SS-64	7 / 21	120	7.8 J	640 J	BH-09	0 - 2	0 / 14	--	--	--	--	--
Endrin Aldehyde	3.4	54	--	--	7 / 13	29	8.3 J	110 J	SS-65	0 / 21	--	--	--	--	--	0 / 14	--	--	--	--	--
Endrin Ketone	3.4	54	--	--	9 / 13	56	5.1 J	170 J	SS-65	4 / 22	16	6.8 J	24 J	BH-04	0 - 4	0 / 14	--	--	--	--	--
alpha-Chlordane	1.8	28	0.27 J		6 / 13	4.4	2.7 J	13 J	SS-73	4 / 21	21	27 J	80 J	BH-08	0 - 2	0 / 14	--	--	--	--	--
gamma-Chlordane	1.8	28	--	--	5 / 13	2.5	3.4 J	7.5 J	SS-73	4 / 21	8.0 *	2.1 J	6.3 J	BH-04	0 - 4	0 / 14	--	--	--	--	--
PCBs (µg/kg)																					
Aroclor-1242	34	540	--	--	0 / 13	--	--	--	--	1 / 21	330	4,000 J		BH-13	4 - 6	3 / 14	620	920	3,800	TP-04	5.0 - 5.2
Aroclor-1248	34	540	--	--	0 / 13	--	--	--	--	7 / 21	620	710 J	3,200 J	BH-11	4 - 6	0 / 14	--	--	--	--	--
Aroclor-1254	34	540	--	--	0 / 13	--	--	--	--	9 / 21	1,600	680 J	8,000 J	BH-07	2 - 6	5 / 14	1,300	1,400 J	8,600 J	TP-04	5.0 - 5.2
Aroclor-1260	34	540	--	--	0 / 13	--	--	--	--	13 / 22	1,500	53 J	7,000 J	BH-07	2 - 6	4 / 14	1,100	590 J	5,400 J	TP-04	5.0 - 5.2
Metals (mg/kg)																					
Aluminum	4.0	10.9	5,350 J	9,630 J	14 / 14	5,420	4,370	7,260 (4)	SS-71	22 / 22	6,250	2,990	16,100	BH-07	0 - 2	14 / 14	5,250	3,330	8,150	TP-14	1.5 - 2.0
Iron	1.0	6.1	4,640	8,350	14 / 14	35,300	8,990	76,800	SS-71	22 / 22	58,900	9,660	147,000	BH-07	2 - 6	14 / 14	62,200	5,680	220,000	TP-04	5.0 - 5.2
Calcium	3.5	28.7	949		14 / 14	3,290	503	14,700 J	SS-71	22 / 22	5,970	781	13,300	BH-13	4 - 6	13 / 14	6,710	414 J	19,200	TP-04	5.0 - 5.2
Magnesium	5.4	95.1	687	1,480	14 / 14	1,930	1,140	4,300	SS-71	22 / 22	3,080	942	8,060	BH-07	0 - 2	14 / 14	2,730	914	7,840	TP-04	5.0 - 5.2
Sodium	7.5	29.9	--	--	0 / 14	--	--	--	--	0 / 22	--	--	--	--	--	1 / 14	252	2,130 J		TP-04	5.0 - 5.2
Potassium	17.3	591.7	--	--	8 / 14	463	472	792	SS-73	22 / 22	552	370	902	BH-11	4 - 6	13 / 14	519	346	875	TP-04	5.0 - 5.2
Barium	3.0	11.6	9.3	32.0	14 / 14	258	26.9	922	SS-71	22 / 22	770	44.0	2,330 J	BH-13	4 - 6	14 / 14	633	12.0	2,430 J	TP-04	5.0 - 5.2
Manganese	0.1	1.0	32.0 J	206 J	14 / 14	396	135 J	1,080 J	SS-64	22 / 22	454	106	864	BH-07	2 - 6	14 / 14	567	88.4	1,620	TP-06	9.0 - 9.2
Beryllium	0.3	1.0	--	--	0 / 14	--	--	--	--	21 / 22	0.50	0.27	1.2	BH-09	2 - 4	12 / 14	0.41	0.22	0.76	TP-11	5.0 - 6.0
Antimony	0.2	1.7	--	--	1 / 14	16.9	155 J		SS-66	10 / 22	17.9	6.1 J	184 J	BH-07	0 - 2	6 / 14	17.8	9.5 J	142 J	TP-03	2.8 - 3.2
Arsenic	0.1	1.0	4.0 J	7.6 J	14 / 14	18.7	7.5	36.0	SS-69	22 / 22	22.9	7.5	45.0	BH-14	4 - 8	14 / 14	23.0	5.1 J	37.3 J	TP-05	4.5 - 5.0
Cadmium	0.3	1.3	--	--	8 / 14	7.6	2.1	34.8 J	SS-71	17 / 22	23.8	0.52	100	BH-07	2 - 6	9 / 14	19.0	0.32	103	TP-04	5.0 - 5.2
Chromium	0.4	2.6	--	--	13 / 14	73.9	13.7 J	304	SS-71	22 / 22	111	14.7 J	582	BH-14	4 - 8	8 / 14	80.4	14.0 J	391	TP-09	3.5 - 4.5
Cobalt	0.3	2.3	--	--	13 / 14	10.0	3.4	26.0	SS-72	22 / 22	16.6	3.2	40.7	BH-08	2 - 6	12 / 14	17.5	4.4	76.0 J	TP-07	4.0 - 4.2
Copper	0.4	3.9	4.7 J	8.9 J	14 / 14	361	50.4	1,030	SS-73	22 / 22	1,700	84.5 J	5,970 J	BH-13	0 - 2	14 / 14	4,640	39.6	47,100 J	TP-03	2.8 - 3.2
Lead	0.2	14.3	102		14 / 14	559	110 J	1,130 J	SS-71	22 / 22	1,230	96.0	5,630	BH-07	2 - 6	14 / 14	982	5.5 J	2,540 J	TP-04	5.0 - 5.2
Mercury	0.05	0.16	--	--	12 / 14	1.1	0.26	3.4	SS-68	21 / 22	1.3	0.19	3.4	BH-07	0 - 2	13 / 14	1.8	0.16 J	3.9	TP-09	3.5 - 4.5
Nickel	0.7	9.0	--	--	9 / 14	60.1	23.5 J	154	SS-71	21 / 22	231	15.2 J	722 J	BH-07	0 - 2	10 / 14	226	14.9	1,470 J	TP-07	4.0 - 4.2
Selenium	0.4	1.2	--	--	4 / 14	0.74	0.78 J	3.1 J	SS-70	11 / 22	2.0	1.9	5.5	BH-07	2 - 6	0 / 14	--	--	--	--	--
Silver	0.7	1.7	--	--	1 / 9	0.52	1.2 J		SS-66	14 / 22	3.8	2.2	9.4	BH-07	2 - 6	13 / 14	5.4	1.1	15.6	TP-03	2.8 - 3.2
Thallium	0.4	1.0	--	--	0 / 14	--	--	--	--	6 / 22	0.49	0.46 J	0.88 J	BH-08	0 - 2	0 / 14	--	--	--	--	--
Vanadium	0.5	2.6	7.2	13.7	14 / 14	17.5	8.7 J	34.8	SS-69	22 / 22	27.7	11.0	47.2	BH-13	4 - 6	14 / 14	31.4	6.9	86.05	TP-04	5.0 - 5.2
Zinc	0.7	1.3	18.4 J	46.6 J	14 / 14	1,240	53.5	4,400	SS-70	22 / 22	4,310	154 J	13,600 J	BH-08	2 - 6	14 / 14	3,390	27.2	12,700	TP-09	3.5 - 4.5
Soil Quality Parameters (mg/kg)																					
Cyanide	0.5	3.2		--	10 / 14	3.8	0.63	39.0	SS-74	2 / 22	1.2 *	0.63	0.76	BH-13	4 - 6	1 / 14	0.34	0.81		TP-09	3.5 - 4.5
Total Petroleum Hydrocarbons	10	7,600	--	--	14 / 14	300	14	800	SS-70	22 / 22	1,400	54	6,000 J	BH-13	4 - 6	11 / 14	5,000	12	18,000	TP-06	9.0 - 9.2
Geotechnical Parameters (%)																					
Total Combustible Organics	--	--	--	--	3 / 3	10	6.8	14	SS-71	10 / 10	17	2.8	40	BH-11	8-10	NA	NA	NA	NA	NA	NA
Soil Moisture Content	--	--	--	--	3 / 3	9	5.9	11	SS-64	10 / 10	19	3.2	47	BH-09	11-15	NA	NA	NA	NA	NA	NA

NOTES:

1 Analytical data is presented in Appendix F.

2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.

3 Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.

4 Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included. A single concentration is presented when only one positive detection has occurred.

5 Although summary data are presented, these analytes are not considered to be site-related as discussed in sections 2.3.2 and 4.2.1.

* - The calculated average is greater than the maximum value.

-- Analyte was not detected in samples from this grouping.

N- Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

TABLE 4-4. SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM THE RSI LANDFILL (1)

			Background Surface Soil		Surface Soil					Borehole Soil						Test Pit Soil					
	Range of SQLs (2)		Range of Values (4)		Frequency of Detection (3)	Arithmetic Average	Range of Values (4)		Maximum Location	Frequency of Detection (3)	Arithmetic Average	Range of Values (4)		Maximum Location	Depth Interval (feet)	Frequency of Detection (3)	Arithmetic Average	Range of Values (4)		Maximu Location	Depth Interval (feet)
Analyte	Minimum	Maximum	Minimum	Maximum			Minimum	Maximum				Minimum	Maximum					Minimum	Maximum		
Volatile Organics (µg/kg)																					
Benzene	10	1,200	--	--	0 / 6	--	--	--	--	1 / 24	5 *	1 J		BH-23	10 - 12	0 / 6	--	--	--	--	--
Toluene	10	1,200	--	--	0 / 6	--	--	--	--	2 / 24	5 *	1 J	3 J	BH-22	2.0 - 4.0	2 / 6	6	5 J	6 J	TP-16	11.0 - 12.0
Ethylbenzene	10	1,200	--	--	0 / 6	--	--	--	--	7 / 24	7	2 J	47	BH-23	10 - 12	1 / 6	8	10 J		TP-16	11.0 - 12.0
Total Xylenes	10	1,200	--	--	0 / 6	--	--	--	--	3 / 24	11	30	60	BH-24	13 - 15	1 / 6	11	27 J		TP-16	11.0 - 12.0
Chlorobenzene	10	1,200	--	--	0 / 6	--	--	--	--	0 / 24	--	--	--	--	--	1 / 6	8	8 J		TP-16	11.0 - 12.0
Styrene	10	1,200	--	--	0 / 6	--	--	--	--	1 / 24	5	6 J		BH-23	10 - 12	0 / 6	--	--	--	--	--
Acetone (5)	10	1,200	--	--	0 / 6	--	--	--	--	1 / 24	17	160 J		BH-23	10 - 12	1 / 6	34	110	110	TP-18	9.5 - 10.0
2-Butanone (5)	10	1,200	--	--	0 / 6	--	--	--	--	2 / 24	6	5 J	8 J	BH-21	10 - 12	0 / 6	--	--	--	--	--
1,2-Dichloroethene(total)	10	1,200	--	--	0 / 6	--	--	--	--	1 / 24	5 *	1 J		BH-24	13 - 15	0 / 6	--	--	--	--	--
Methylene Chloride (5)	10	1,200	7 J	36	2 / 6	120 *	14 J	64	SS-07	0 / 24	--	--	--	--	--	0 / 6	--	--	--	--	--
Carbon Disulfide	10	1,200	--	--	0 / 6	--	--	--	--	3 / 24	5	1 J	6 J	BH-23	10 - 12	0 / 6	--	--	--	--	--
Semivolatile Organics (µg/kg)																					
Naphthalene	330	14,000	--	--	0 / 6	--	--	--	--	10 / 23	680	98 J	4,600 J	BH-23	10 - 12	3 / 6	470	290 J	1,500 J	TP-16	11.0 - 12.0
2-Methylnaphthalene	330	14,000	--	--	0 / 6	--	--	--	--	8 / 23	590	93 J	1,100 J	BH-22	6.0 - 8.0	3 / 6	220	60 J	420 J	TP-16	11.0 - 12.0
Acenaphthylene	330	14,000	--	--	0 / 6	--	--	--	--	3 / 23	480 *	38 J	160 J	BH-22	6.0 - 8.0	1 / 6	190 *	79 J		TP-16	11.0 - 12.0
Acenaphthene	330	14,000	--	--	0 / 6	--	--	--	--	6 / 23	550	49 J	1,100 J	BH-22	6.0 - 8.0	2 / 6	190	210 J	250 J	TP-18	9.5 - 10.0
Fluorene	330	14,000	--	--	0 / 6	--	--	--	--	8 / 23	510	60 J	760 J	BH-24	4.0 - 10	2 / 6	200	190 J	330 J	TP-18	9.5 - 10.0
Phenanthrene	330	14,000	--	--	0 / 6	--	--	--	--	16 / 23	430	26 J	2,000 J	BH-22	6.0 - 8.0	3 / 6	380	120 J	1,200	TP-18	9.5 - 10.0
Anthracene	330	14,000	--	--	0 / 6	--	--	--	--	8 / 23	470 *	33 J	240 J	BH-24	4.0 - 10	2 / 6	160	64 J	170 J	TP-18	9.5 - 10.0
Fluoranthene	330	14,000	--	--	3 / 6	190	120 J	390	SS-06	17 / 23	440	18 J	2,100 J	BH-22	6.0 - 8.0	3 / 6	420	120 J	1,200 J	TP-16	9.5 - 10.0
Pyrene	330	14,000	--	--	3 / 6	190	130 J	330 J	SS-06	16 / 23	430	19 J	1,600 J	BH-22	6.0 - 8.0	3 / 6	700	100 J	2,300 J	TP-18	9.5 - 10.0
Benzo(a)anthracene	330	14,000	--	--	1 / 6	160 *	120 J		SS-06	13 / 23	520	23 J	880 J	BH-22	6.0 - 8.0	2 / 6	260	300 J	530 J	TP-18	9.5 - 10.0
Chrysene	330	14,000	--	--	2 / 6	190	110 J	340	SS-06	12 / 23	540	37 J	700 J	BH-18	2.0 - 4.0	3 / 6	280	70 J	730 J	TP-18	9.5 - 10.0
Benzo(b)fluoranthene	330	14,000	--	--	3 / 6	210	150 J	380	SS-06	11 / 23	570	59 J	1,200 J	BH-18	2.0 - 4.0	3 / 6	250	53 J	660 J	TP-18	9.5 - 10.0
Benzo(k)fluoranthene	330	14,000	--	--	0 / 6	--	--	--	--	11 / 23	510	40 J	690 J	BH-18	2.0 - 4.0	2 / 6	240	350 J	360 J	TP-18	9.5 - 10.0
Benzo(a)pyrene	330	14,000	--	--	0 / 6	--	--	--	--	10 / 23	500	41 J	500 J	BH-18	2.0 - 4.0	3 / 6	230	97 J	470 J	TP-18	9.5 - 10.0
Dibenz(a,h)anthracene	330	14,000	--	--	0 / 6	--	--	--	--	6 / 23	460 *	56 J	130 J	BH-18	2.0 - 4.0	2 / 6	210	210 J	340 J	TP-18	9.5 - 10.0
Benzo(g,h,i)perylene	330	14,000	--	--	0 / 6	--	--	--	--	2 / 23	490 *	72 J	82 J	BH-18	2.0 - 4.0	3 / 6	270	100 J	550 J	TP-18	9.5 - 10.0
Indeno(1,2,3-cd)pyrene	330	14,000	--	--	0 / 6	--	--	--	--	7 / 23	480 *	59 J	360 J	BH-18	2.0 - 4.0	3 / 6	260	50 J	540 J	TP-18	9.5 - 10.0
1,2-Dichlorobenzene	330	14,000	--	--	0 / 6	--	--	--	--	1 / 23	500 *	67 J		BH-24	4.0 - 10	2 / 6	190 *	60 J	180 J	TP-16	11.0 - 12.0
1,4-Dichlorobenzene	330	14,000	--	--	0 / 6	--	--	--	--	3 / 23	300	89 J	2,400 J	BH-23	10 - 12	4 / 6	220	59 J	480	TP-17	11.0-12.0
Dibenzofuran	330	14,000	--	--	0 / 6	--	--	--	--	6 / 23	510	41 J	620 J	BH-22	6.0 - 8.0	2 / 6	180	150 J	220 J	TP-18	9.5 - 10.0
N-Nitrosodiphenylamine	330	14,000	--	--	0 / 6	--	--	--	--	0 / 23	--	--	--	--	--	1 / 6	210 *	210 J		TP-16	11.0 - 12.0
Phenol	330	14,000	--	--	2 / 6	170	110 J	220 J	SS-07	0 / 23	--	--	--	--	--	0 / 6	--	--	--	--	--
4-Methylphenol	330	14,000	--	--	0 / 6	--	--	--	--	4 / 23	490 *	73 J	330 J	BH-24	4.0 - 10	3 / 6	230	120 J	420 J	TP-16	11.0 - 12.0
4-Chloro-3-methylphenol	330	14,000	--	--	0 / 6	--	--	--	--	0 / 23	--	--	--	--	--	1 / 6	170 *	120 J		TP-18	9.5 - 10.0
Diethylphthalate	330	14,000	--	--	0 / 6	--	--	--	--	0 / 23	--	--	--	--	--	1 / 6	190 *	81 J		TP-16	11.0 - 12.0
Di-n-butylphthalate	330	14,000	--	--	0 / 6	--	--	--	--	3 / 23	450	450 J	5,300 J	BH-23	10 - 12	1 / 6	470	1,750 J		TP-16	11.0 - 12.0
Bis(2-ethylhexyl)phthalate	330	14,000	--	--	0 / 6	--	--	--	--	8 / 23	4,100	2,000 J	68,000 J	BH-23	10 - 12	4 / 6	1500	540 J	4,500 J	TP-18	9.5 - 10.0
Di-n-octylphthalate	330	14,000	--	--	0 / 6	--	--	--	--	3 / 23	1,500	320 J	22,000 J	BH-21	10 - 12	2 / 6	900 *	87 J	110 J	TP-17	11.0 - 12.0
Butylbenzylphthalate	330	14,000	--	--	0 / 6	--	--	--	--	8 / 23	570	65 J	5,800 J	BH-23	10 - 12	3 / 6	160	95 J	190 J	TP-16	11.0 - 12.0
Carbazole	330	14,000	--	--	0 / 6	--	--	--	--	7 / 23	470 *	30 J	205 J	BH-24	4.0 - 10	2 / 6	160 *	90 J	140 J	TP-18	9.5 - 10.0
Pesticides (µg/kg)																					
beta-BHC	1.7	19	--	--	0 / 6	--	--	--	--	1 / 20	1.1 *	1.0 J		BH-21	10 - 12	1 / 6	2.4	5.6		TP-18	9.5 - 10.0
delta-BHC	1.7	19	--	--	0 / 6	--	--	--	--	3 / 21	2.1	2.3 J	15 J	BH-23	10 - 12	0 / 6	--	--	--	--	--
4,4'-DDE	3.3	37	1.6 J	4.9 J	5 / 6	1.0	0.60 J	1.4 J	SS-07	5 / 21	5.6	2.6 J	60 J	BH-23	10 - 12	1 / 6	24	133.5 J		TP-16	11.0 - 12.0
4,4'-DDD	3.3	37	1.3 J	2.6 J	5 / 6	0.95	0.25 J	1.6 J	SS-06	9 / 21	35	4.6 J	630 J	BH-23	10 - 12	3 / 6	52	14 J	270 J	TP-16	11.0 - 12.0
4,4'-DDT	3.3	37	2.9 J	7.7 J	6 / 6	2.5	0.40 J	5.2 J	SS-07	12 / 21	6.6	1.8 J	44 J	BH-23	10 - 12	1 / 6	4.0	15 J		TP-16	11.0 - 12.0
Methoxychlor	17	190	1.8 J		3 / 6	5.7 *	0.70 J	4.0 J	SS-10	0 / 20	--	--	--	--	--	0 / 6	--	--	--	--	--
Heptachlor	1.7	19	--	--	0 / 6	--	--	--	--	1 / 21	1.8	16 J		BH-23	10 - 12	0 / 6	--	--	--	--	--
Heptachlor Epoxide	1.7	19	0.62 J	2.0 J	2 / 6	0.81 *	0.50 J	0.75 J	SS-06	1 / 20	1.1	1.2 J		BH-22	6.0 - 8.0	0 / 6	--	--	--	--	--
Endosulfan I	1.7	19	--	--	0 / 6	--	--	--	--	1 / 21	11	180 J		BH-23	10 - 12	0 / 6	--	--	--	--	--
Endosulfan II	3.3	37	0.60 J	1.0 J	1 / 6	1.5 *	0.51 J		SS-10	1 / 20	2.4	5.7 J		BH-22	6.0 - 8.0	0 / 6	--	--	--	--	--
Endosulfan Sulfate	3.3	37	--	--	0 / 6	--	--	--	--	3 / 20	2.8	4.7 J	9.4 J	BH-24	4.0 - 10	0 / 6	--	--	--	--	--
Aldrin	1.7	19	--	--	0 / 6	--	--	--	--	2 / 20	1.3	2.6 J	3.2 J	BH-21	8.0 - 10	0 / 6	--	--	--	--	--
Dieldrin	3.3	37	2.1 J		0 / 6	--	--	--	--	5 / 21	3.4	2.2 J	23 J	BH-23	10 - 12	0 / 6	--	--	--	--	--
Endrin	3.3	37	--	--	4 / 6	1.0	0.38 J	1.4 J	SS-07	6 / 21	2.9	2.3 J	12 J	BH-23	10 - 12	2 / 6	5.0	7.2 J	8.1 J	TP-17	11.0 - 12.0
Endrin Aldehyde	3.3	37	--	--	0 / 6	--	--	--	--	4 / 20	3.2	2.0 J	15 J	BH-23	4.0 - 8.0	0 / 6	--	--	--	--	--

TABLE 4-4 (Continued). SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM THE RSI LANDFILL (1)

Analyte	Range of SQLs (2) Minimum	Range of SQLs (2) Maximum	Background Surface Soil Range of Values (4) Minimum	Background Surface Soil Range of Values (4) Maximum	Surface Soil Frequency of Detection (3)	Surface Soil Arithmetic Average	Surface Soil Range of Values (4) Minimum	Surface Soil Range of Values (4) Maximum	Surface Soil Maximum Location	Borehole Soil Frequency of Detection (3)	Borehole Soil Arithmetic Average	Borehole Soil Range of Values (4) Minimum	Borehole Soil Range of Values (4) Maximum	Borehole Soil Maximum Location	Borehole Soil Depth Interval (feet)	Test Pit Soil Frequency of Detection (3)	Test Pit Soil Arithmetic Average	Test Pit Soil Range of Values (4) Minimum	Test Pit Soil Range of Values (4) Maximum	Test Pit Soil Maximu Location	Test Pit Soil Depth Interval (feet)
Pesticides (continued) (µg/kg)																					
Endrin Ketone	3.3	37	--	--	3 / 6	1.2 *	0.46 J	0.87 J	SS-09	4 / 21	3.7	1.8 J	28 J	BH-23	10 - 12	0 / 6	--	--	--	--	--
alpha-Chlordane	1.7	19	0.27 J		0 / 6	--	--	--	--	6 / 21	10	1.7 J	160 J	BH-23	10 - 12	1 / 6	1.8	2.3 J		TP-17	11.0 - 12.0
gamma-Chlordane	1.7	19	--	--	1 / 6	0.81 *	0.33 J		SS-07	7 / 21	7.2	1.2 J	120 J	BH-23	10 - 12	1 / 6	2.2	4.6 J		TP-18	9.5 - 10.0
PCBs (µg/kg)																					
Aroclor-1242	33	370	--	--	0 / 6	--	--	--	--	8 / 21	220	74 J	2,700 J	BH-23	10 - 12	2 / 6	90	84	310	TP-18	9.5 - 10.0
Aroclor-1254	33	370	--	--	0 / 6	--	--	--	--	7 / 21	110	31 J	890 J	BH-23	4.0 - 8.0	0 / 6	--	--	--	--	--
Aroclor-1260	33	370	--	--	0 / 6	--	--	--	--	3 / 20	45	29 J	420 J	BH-22	6.0 - 8.0	1 / 6	41	82 J		TP-18	9.5 - 10.0
Metals (mg/kg)																					
Aluminum	3.8	10.0	5,350 J	9,630 J	6 / 6	7,180	6,120 J	9,470 J	SS-08	23 / 23	5,630	3,200	7,920	BH-15	4.0 - 6.0	6 / 6	5,430	4,910	6,230	TP-19	9.0 - 10.0
Iron	1.0	3.7	4,640	8,350	6 / 6	9,710	6,810	13,600	SS-08	23 / 23	9,540	5,610	22,800	BH-23	4.0 - 8.0	6 / 6	7,520	5,470	10,700	TP-16	11.0 - 12.0
Calcium	7.0	26.6	949		6 / 6	794	313 J	1,180	SS-05	20 / 23	1,220	446	6,270	BH-23	10 - 12	6 / 6	1,960	545 J	3,890 J	TP-17	11.0 - 12.0
Magnesium	5.2	88.0	687	1,480	6 / 6	2,560	1,360	3,780	SS-06	23 / 23	2,030	1,380	3,010	BH-15	4.0 - 6.0	6 / 6	1,520	1,040	1,740	TP-18	9.5 - 10.0
Potassium	16.9	547.8	--	--	5 / 6	1,370	689	1,990	SS-05	23 / 23	925	653	1,420	BH-25	12 - 14	6 / 6	683	401	1,040	TP-19	9.0 - 10.0
Barium	2.9	10.8	9.3	32.0	6 / 6	29.8	15.2	46.0	SS-08	23 / 23	31.4	14.4	155	BH-23	10 - 12	6 / 6	28.0	14.1	49.4	TP-16	11.0 - 12.0
Manganese	0.1	1.0	32.0 J	206 J	6 / 6	161	131 J	212 J	SS-08	23 / 23	174	69.9 J	727	BH-23	10 - 12	6 / 6	101	69.4	134	TP-18	9.5 - 10.0
Beryllium	0.3	1.0	--	--	0 / 6	--	--	--	--	22 / 23	0.42	0.28	0.70	BH-23	4.0 - 8.0	6 / 6	0.25	0.20	0.31	TP-19	9.0 - 10.0
Antimony	0.2	1.2	--	--	0 / 6	--	--	--	--	4 / 18	2.3	4.0 J	6.3 J	BH-23	4.0 - 8.0	0 / 6	--	--	--	--	--
Arsenic	0.1	1.0	4.0 J	7.6 J	6 / 6	4.5	3.9 J	4.8 J	SS-08	23 / 23	6.7	4.2	16.6	BH-22	6.0 - 8.0	6 / 6	7.7	4.7 J	12.4 J	TP-18	9.5 - 10.0
Cadmium	0.3	1.2	--	--	0 / 6	--	--	--	--	1 / 23	0.22	1.8 J		BH-23	10 - 12	0 / 6	--	--	--	--	--
Chromium	0.4	2.4	--	--	4 / 6	13.9	15.7 J	23.7 J	SS-07	11 / 23	14.7	15.4 J	42.9 J	BH-23	10 - 12	2 / 6	13.2	29.0	31.1	TP-16	11.0 - 12.0
Cobalt	0.3	2.2	--	--	6 / 6	3.9	2.2 J	6.5	SS-08	19 / 23	3.6	2.2 J	6.4	BH-23	4.0 - 8.0	2 / 6	2.5	4.4	4.5	TP-16	11.0 - 12.0
Copper	0.4	3.6	4.7 J	8.9 J	5 / 6	11.7	10.7 J	19.7 J	SS-07	18 / 23	39.8	8.1 J	338 J	BH-23	10 - 12	2 / 6	14.1	29.8	31.4	TP-18	9.5 - 10.0
Lead	0.2	6.0	102		6 / 6	58.8	4.0	248 J	SS-08	20 / 23	45.8	3.2 J	356	BH-23	10 - 12	6 / 6	22.0	3.6 J	48.4	TP-16	11.0 - 12.0
Mercury	0.05	0.12	--	--	0 / 6	--	--	--	--	9 / 23	0.10	0.04 J	0.80	BH-23	10 - 12	2 / 6	0.08	0.16	0.24	TP-16	11.0 - 12.0
Nickel	0.7	8.4	--	--	0 / 6	--	--	--	--	6 / 23	11.0	15.1 J	62.5 J	BH-23	4.0 - 8.0	0 / 6	--	--	--	--	--
Selenium	0.4	0.8	--	--	0 / 6	--	--	--	--	5 / 23	0.46	0.23 J	1.0 J	BH-22	6.0 - 8.0	0 / 6	--	--	--	--	--
Silver	0.7	1.2	--	--	0 / 6	--	--	--	--	4 / 23	0.66	0.93 J	2.1	BH-23	4.0 - 8.0	2 / 6	0.58	0.97	1.1	TP-16	11.0 - 12.0
Vanadium	0.5	2.4	7.2	13.7	6 / 6	15.3	9.4	20.2	SS-08	23 / 23	13.8	8.8	23.6	BH-23	10 - 12	6 / 6	11.4	9.1	16.7	TP-16	11.0 - 12.0
Zinc	0.7	1.2	18.4 J	46.6 J	6 / 6	34.2	20.4 J	59.0 J	SS-08	18 / 23	80.9	18.0 J	605	BH-23	4.0 - 8.0	4 / 6	61.2	29.0	116	TP-16	11.0 - 12.0
Soil Quality Parameters (mg/kg)																					
Cyanide	0.5	0.6	--	--	0 / 6	--	--	--	--	1 / 23	0.27	0.63		BH-22	6.0 - 8.0	0 / 6	--	--	--	--	--
Total Petroleum Hydrocarbons	10	1,200	--	--	1 / 6	7	14		SS-08	11 / 23	450	48 J	3,900 J	BH-23	10 - 12	3 / 6	760	150	3,200	TP-16	11.0 - 12.0
Geotechnical Parameters (%)																					
Total Combustible Organics	--	--	--	--	1 / 1	2.7	2.7		SS-10	5 / 5	1.4	0.33	4.8	BH-25	4-6	NA	NA	NA	NA	NA	NA
Soil Moisture Content	--	--	--	--	1 / 1	5.8	6		SS-10	5 / 5	6.5	2.5	11	BH-25	8-10	NA	NA	NA	NA	NA	NA

NOTES:

1 Analytical data is presented in Appendix F.

2 SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.

3 Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.

4 Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included. A single concentration is presented when only one positive detection has occurred.

5 Although summary data are presented, these analytes are not considered to be site-related as discussed in sections 2.3.2 and 4.2.1.

* - The calculated average is greater than the maximum value.

-- Analyte was not detected in samples from this grouping.

N- Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

TABLE 4-5. SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM B&M LOCOMOTIVE SHOP DISPOSAL AREA A (1)

Analyte	Range of SQLs (2)		Background Surface Soil Range of Values (4)		Surface Soil			Borehole Soil						Test Pit Soil			
	Minimum	Maximum	Minimum	Maximum	Frequency of Detection	Value Detected (4)	Maximum Location	Frequency of Detection (3)	Arithmetic Average	Range of Values (4) Minimum	Range of Values (4) Maximum	Maximum Location	Depth Interval (feet)	Frequency of Detection (3)	Value Detected (4)	Maximum Location	Depth Interval (feet)
Volatile Organics (µg/kg)																	
Toluene	11	12	--	--	0 / 1	--	--	2 / 3	4	2 J	4 J	BH-27	0 - 2	0 / 1	--	--	--
Methylene Chloride (5)	11	12	7 J	36	1 / 1	21 J	SS-04	0 / 3	--	--	--	--	--	0 / 1	--	--	--
Semivolatile Organics (µg/kg)																	
Naphthalene	350	410	--	--	1 / 1	180 J	SS-04	3 / 3	190	120 J	230 J	BH-28	2 - 4	0 / 1	--	--	--
2-Methylnaphthalene	350	410	--	--	1 / 1	220 J	SS-04	3 / 3	290	140 J	370 J	BH-28	2 - 4	0 / 1	--	--	--
Acenaphthylene	350	410	--	--	0 / 1	--	--	1 / 3	140 *	47 J		BH-28	2 - 4	0 / 1	--	--	--
Acenaphthene	350	410	--	--	0 / 1	--	--	1 / 3	150 *	56 J		BH-28	0 - 2	0 / 1	--	--	--
Fluorene	350	410	--	--	0 / 1	--	--	1 / 3	150 *	53 J		BH-28	0 - 2	0 / 1	--	--	--
Phenanthrene	350	410	--	--	1 / 1	420 J	SS-04	3 / 3	530	360 J	710 J	BH-28	2 - 4	0 / 1	--	--	--
Anthracene	350	410	--	--	0 / 1	--	--	3 / 3	77	49 J	110 J	BH-28	0 - 2	0 / 1	--	--	--
Fluoranthene	350	410	--	--	1 / 1	550 J	SS-04	3 / 3	680	430 J	950 J	BH-28	2 - 4	0 / 1	--	--	--
Pyrene	350	410	--	--	1 / 1	570	SS-04	3 / 3	650	510 J	820 J	BH-28	2 - 4	0 / 1	--	--	--
Benzo(a)anthracene	350	410	--	--	1 / 1	380 J	SS-04	3 / 3	410	230 J	630 J	BH-28	2 - 4	0 / 1	--	--	--
Chrysene	350	410	--	--	1 / 1	460	SS-04	3 / 3	360	200 J	450 J	BH-27	0 - 2	0 / 1	--	--	--
Benzo(b)fluoranthene	350	410	--	--	1 / 1	700	SS-04	3 / 3	470	180 J	620 J	BH-27	0 - 2	0 / 1	--	--	--
Benzo(k)fluoranthene	350	410	--	--	0 / 1	--	--	3 / 3	290	160 J	420 J	BH-27	0 - 2	0 / 1	--	--	--
Benzo(a)pyrene	350	410	--	--	1 / 1	350 J	SS-04	3 / 3	220	130 J	310 J	BH-28	2 - 4	0 / 1	--	--	--
Dibenz(a,h)anthracene	350	410	--	--	0 / 1	--	--	3 / 3	83	29 J	120 J	BH-27	0 - 2	0 / 1	--	--	--
Benzo(g,h,i)perylene	350	410	--	--	1 / 1	200 J	SS-04	2 / 3	120	57 J	140 J	BH-27	0 - 2	0 / 1	--	--	--
Indeno(1,2,3-cd)pyrene	350	410	--	--	1 / 1	180 J	SS-04	3 / 3	190	78 J	290 J	BH-27	0 - 2	0 / 1	--	--	--
Dibenzofuran	350	410	--	--	0 / 1	--	--	3 / 3	100	72 J	120 J	BH-28	2 - 4	0 / 1	--	--	--
Carbazole	350	410	--	--	0 / 1	--	--	3 / 3	77	57 J	100 J	BH-28	2 - 4	0 / 1	--	--	--
Pesticides (µg/kg)																	
4,4'-DDE	3.5	4.1	1.6 J	4.9 J	1 / 1	1.5 J	SS-04	0 / 3	--	--	--	--	--	0 / 1	--	--	--
4,4'-DDD	3.5	4.1	1.3 J	2.6 J	1 / 1	5.0 J	SS-04	2 / 3	2.6	2.4 J	3.5 J	BH-27	0 - 2	0 / 1	--	--	--
4,4'-DDT	3.5	4.1	2.9 J	7.7 J	1 / 1	6.6 J	SS-04	2 / 3	3.2	3.6 J	4.2 J	BH-27	0 - 2	0 / 1	--	--	--
Methoxychlor	18	21	1.8 J		1 / 1	19 J	SS-04	0 / 3	--	--	--	--	--	0 / 1	--	--	--
Heptachlor Epoxide	1.8	2.1	0.62 J	2.0 J	1 / 1	1.8 J	SS-04	2 / 3	1.7	0.97 J	3.3 J	BH-27	0 - 2	0 / 1	--	--	--
Endosulfan II	3.5	4.1	0.60 J	1.0 J	1 / 1	1.9 J	SS-04	3 / 3	5.5	2.7 J	7.7 J	BH-27	0 - 2	0 / 1	--	--	--
Aldrin	1.8	2.1	--	--	1 / 1	2.8 J	SS-04	3 / 3	3.3	1.2 J	4.7 J	BH-27	0 - 2	0 / 1	--	--	--
Dieldrin	3.5	4.1	2.1 J		1 / 1	1.7 J	SS-04	0 / 3	--	--	--	--	--	0 / 1	--	--	--
Endrin	3.5	4.1	--	--	1 / 1	3.5 J	SS-04	2 / 3	3.2	2.6 J	5.2 J	BH-27	0 - 2	0 / 1	--	--	--
Endrin Aldehyde	3.5	4.1	--	--	0 / 1	--	--	2 / 3	7.6	9.1 J	12 J	BH-28	2 - 4	0 / 1	--	--	--
Endrin Ketone	3.5	4.1	--	--	0 / 1	--	--	1 / 3	2.0	2.1 J		BH-28	0 - 2	0 / 1	--	--	--
alpha-Chlordane	1.8	2.1	0.27 J		1 / 1	1.0 J	SS-04	0 / 3	--	--	--	--	--	0 / 1	--	--	--
gamma-Chlordane	1.8	2.1	--	--	1 / 1	4 J	SS-04	1 / 3	1.2	1.7 J		BH-27	0 - 2	0 / 1	--	--	--
PCBs (µg/kg)																	
None Detected																	
Metals (mg/kg)																	
Aluminum	4.3	10.3	5,350 J	9,630 J	1 / 1	5,270 J	SS-04	3 / 3	6,260	5,190	8,370	BH-27	0 - 2	1 / 1	4,480	TP-24	2.0 - 2.5
Iron	1.2	3.7	4,640	8,350	1 / 1	101,000	SS-04	3 / 3	46,800	11,700	98,900	BH-27	0 - 2	1 / 1	5,150	TP-24	2.0 - 2.5
Calcium	8.2	27.1	949		1 / 1	6,090	SS-04	3 / 3	11,000	5,980	15,000	BH-28	2 - 4	0 / 1	--	--	--
Magnesium	6.1	89.9	687	1,480	1 / 1	4,230	SS-04	3 / 3	3,800	1,670	6,020	BH-27	0 - 2	1 / 1	1,140	TP-24	2.0 - 2.5
Potassium	19.7	559	--	--	1 / 1	424 J	SS-04	3 / 3	635	516	864	BH-27	0 - 2	1 / 1	373	TP-24	2.0 - 2.5
Barium	0.2	1.2	9.3	32.0	1 / 1	342	SS-04	3 / 3	139	43.3	299	BH-27	0 - 2	1 / 1	6.2	TP-24	2.0 - 2.5
Manganese	0.1	1.0	32.0 J	206 J	1 / 1	917 J	SS-04	3 / 3	284	101	498	BH-27	0 - 2	1 / 1	126	TP-24	2.0 - 2.5
Beryllium	0.1	1.0	--	--	1 / 1	0.85 J	SS-04	3 / 3	0.81	0.42	1.3	BH-27	0 - 2	1 / 1	0.23	TP-24	2.0 - 2.5
Antimony	3.2	11.0	--	--	1 / 1	53.0 J	SS-04	3 / 3	163	4.5 J	478 J	BH-27	0 - 2	0 / 1	--	--	--
Arsenic	0.3	1.0	4.0 J	7.6 J	1 / 1	49.3 J	SS-04	3 / 3	32.1	8.5	73.2	BH-27	0 - 2	1 / 1	7.2 J	TP-24	2.0 - 2.5
Cadmium	0.3	1.2	--	--	1 / 1	1.0 J	SS-04	0 / 3	--	--	--	--	--	0 / 1	--	--	--
Chromium	0.4	2.4	--	--	1 / 1	87.4 J	SS-04	3 / 3	25.1	9.9 J	41.5 J	BH-27	0 - 2	0 / 1	--	--	--
Cobalt	0.3	2.2	--	--	1 / 1	13.9	SS-04	3 / 3	8.6	4.4	15.6	BH-27	0 - 2	1 / 1	5.9	TP-24	2.0 - 2.5
Copper	0.5	3.7	4.7 J	8.9 J	1 / 1	3,140 J	SS-04	3 / 3	1,060	149 J	2,660 J	BH-27	0 - 2	1 / 1	32.0	TP-24	2.0 - 2.5

TABLE 4-5 (Continued). SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM B&M LOCOMOTIVE SHOP DISPOSAL AREA A (1)

	Range of SQLs (2)		Background Surface Soil Range of Values (4)		Surface Soil			Borehole Soil						Test Pit Soil			
Analyte	Minimum	Maximum	Minimum	Maximum	Frequency of Detection (3)	Value Detected (4)	Maximum Location	Frequency of Detection (3)	Arithmetic Average	Range of Values (4) Minimum	Range of Values (4) Maximum	Maximum Location	Depth Interval (feet)	Frequency of Detection (3)	Value Detected (4)	Maximum Location	Depth Interval (feet)
Metals (continued) (mg/kg)																	
Lead	0.2	6.1	102		1 / 1	2,370 J	SS-04	3 / 3	2,980	161	8,380	BH-27	0 - 2	1 / 1	12.5 J	TP-24	2.0 - 2.5
Mercury	0.05	0.12	--	--	1 / 1	0.19 J	SS-04	3 / 3	1.1	0.07	3.0	BH-27	0 - 2	0 / 1	--	--	--
Nickel	0.9	8.5	--	--	1 / 1	46.5	SS-04	3 / 3	24.6	8.7 J	46.2 J	BH-27	0 - 2	0 / 1	--	--	--
Selenium	0.5	0.9	--	--	1 / 1	5.5	SS-04	3 / 3	7.8	1.5 J	19.3	BH-27	0 - 2	0 / 1	--	--	--
Silver	0.8	1.2	--	--	0 / 1	--	--	2 / 3	2.6	1.2	6.2	BH-27	0 - 2	0 / 1	--	--	--
Thallium	0.5	0.7	--	--	1 / 1	0.57 J	SS-04	3 / 3	1.9	0.27 J	4.8	BH-27	0 - 2	0 / 1	--	--	--
Vanadium	0.5	2.4	7.2	13.7	1 / 1	17.2	SS-04	3 / 3	19.8	10.6	34.3	BH-27	0 - 2	1 / 1	7.6	TP-24	2.0 - 2.5
Zinc	0.8	1.2	18.4 J	46.6 J	1 / 1	821 J	SS-04	3 / 3	297	84.5	657	BH-27	0 - 2	0 / 1	--	--	--
Soil Quality Parameters (mg/kg)																	
Cyanide	0.5	0.6	--	--	1 / 1	0.94	SS-04	0 / 3	--	--	--	--	--	0 / 1	--	--	--
Total Petroleum Hydrocarbons	11	60	--	--	1 / 1	140	SS-04	2 / 3	32	26 J	62 J	BH-28	2 - 4	0 / 1	--	--	--
Geotechnical Parameters (%)																	
Total Combustible Organics	--	--	--	--	NA	NA	NA	1 / 1	18	18		BH-27	0 - 2	NA	NA	NA	NA
Soil Moisture Content	--	--	--	--	NA	NA	NA	1 / 1	22	22		BH-27	0 - 2	NA	NA	NA	NA

NOTES:

1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included. A single concentration is presented when only one positive detection has occurred.
5. Although summary data are presented, these analytes are not considered to be site-related as discussed in sections 2.3.2 and 4.2.1.

* - The calculated average is greater than the maximum value.
-- Analyte was not detected in samples from this grouping.
NA - Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

TABLE 4-6. SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM THE B&M LOCOMOTIVE SHOP DISPOSAL AREA B (1)

Analyte	Range of SQLs (2)		Background Surface Soil Range of Values (4)		Surface Soil					Borehole Soil						Test Pit Soil					
	Minimum	Maximum	Minimum	Maximum	Frequency of Detection (3)	Arithmetic Average	Range of Values (4) Minimum	Range of Values (4) Maximum	Maximum Location	Frequency of Detection (3)	Arithmetic Average	Range of Values (4) Minimum	Range of Values (4) Maximum	Maximum Location	Depth Interval (feet)	Frequency of Detection (3)	Arithmetic Average	Range of Values (4) Minimum	Range of Values (4) Maximum	Maximum Location	Depth Interval (feet)
Volatile Organics (µg/kg)																					
Benzene	10	13	--	--	0 / 3	--	--	--	--	1 / 12	5 *	1 J		BH-31	4 - 6	0 / 3	--	--	--	--	--
Tetrachloroethene	10	13	--	--	0 / 3	--	--	--	--	0 / 12	--	--	--	--	--	1 / 3	5 *	3 J		TP-22	5.0 - 7.0
Methylene Chloride (5)	10	13	7 J	36	1 / 3	8	13		SS-01	0 / 12	--	--	--	--	--	0 / 3	--	--	--	--	--
Semivolatile Organics (µg/kg)																					
Naphthalene	340	710	--	--	1 / 3	210	290 J		SS-03	8 / 12	290	36 J	1,200 J	BH-31	4 - 6	2 / 3	410	500	560	TP-21	10.0 - 10.5
2-Methylnaphthalene	340	710	--	--	1 / 3	240	370		SS-03	7 / 12	320	80 J	870 J	BH-34	2 - 4	3 / 3	580	270 J	850	TP-21	10.0 - 10.5
Acenaphthylene	340	710	--	--	0 / 3	--	--	--	--	3 / 12	190	53 J	430 J	BH-31	4 - 6	0 / 3	--	--	--	--	--
Acenaphthene	340	710	--	--	1 / 3	380	790		SS-03	3 / 12	290	38 J	1,600 J	BH-31	4 - 6	1 / 3	140 *	48 J		TP-23	7.0 - 8.0
Fluorene	340	710	--	--	1 / 3	370	760		SS-03	4 / 12	360	37 J	2,600 J	BH-31	4 - 6	2 / 3	100 *	59 J	70 J	TP-23	7.0 - 8.0
Phenanthrene	340	710	--	--	3 / 3	2,100	100 J	5,900 J	SS-03	11 / 12	2,300	66 J	24,000 J	BH-31	4 - 6	3 / 3	540	240 J	780	TP-23	7.0 - 8.0
Anthracene	340	710	--	--	1 / 3	610	1,500		SS-03	7 / 12	770	24 J	7,700 J	BH-31	4 - 6	2 / 3	100 *	50 J	82 J	TP-23	7.0 - 8.0
Fluoranthene	340	710	--	--	3 / 3	1,700	140 J	4,200 J	SS-03	12 / 12	2,600	48 J	28,000 J	BH-31	4 - 6	3 / 3	320	210 J	500	TP-23	7.0 - 8.0
Pyrene	340	710	--	--	3 / 3	1,900	170 J	4,800 J	SS-03	12 / 12	2,100	60 J	22,000 J	BH-31	4 - 6	3 / 3	600	340 J	790 J	TP-21	10.0 - 10.5
Benzo(a)anthracene	340	710	--	--	2 / 3	940	340	2,300	SS-03	12 / 12	1,300	37 J	14,000 J	BH-31	4 - 6	3 / 3	280	120 J	360 J	TP-23	7.0 - 8.0
Chrysene	340	710	--	--	2 / 3	980	360	2,400	SS-03	12 / 12	1,200	47 J	12,000 J	BH-31	4 - 6	3 / 3	370	140 J	550 J	TP-21	10.0 - 10.5
Benzo(b)fluoranthene	340	710	--	--	2 / 3	1,200	540	2,900 J	SS-03	10 / 12	930	45 J	8,400 J	BH-31	4 - 6	3 / 3	310	150 J	440 J	TP-21	10.0 - 10.5
Benzo(k)fluoranthene	340	710	--	--	0 / 3	--	--	--	--	9 / 12	620	38 J	5,400 J	BH-31	4 - 6	3 / 3	220	48 J	390 J	TP-21	10.0 - 10.5
Benzo(a)pyrene	340	710	--	--	2 / 3	700	230 J	1,700	SS-03	10 / 12	1,100	39 J	11,000 J	BH-31	4 - 6	3 / 3	230	84 J	350 J	TP-21	10.0 - 10.5
Dibenz(a,h)anthracene	340	710	--	--	1 / 3	250	400		SS-03	6 / 12	270	23 J	1,700 J	BH-31	4 - 6	2 / 3	210	190 J	250 J	TP-21	10.0 - 10.5
Benzo(g,h,i)perylene	340	710	--	--	2 / 3	420	130 J	960	SS-03	3 / 12	320	120 J	1,800 J	BH-31	4 - 6	2 / 3	350	420	460 J	TP-21	10.0 - 10.5
Indeno(1,2,3-cd)pyrene	340	710	--	--	2 / 3	400	110 J	920	SS-03	6 / 12	450	49 J	3,400 J	BH-31	4 - 6	2 / 3	330	390 J	420 J	TP-21	10.0 - 10.5
Dibenzofuran	340	710	--	--	1 / 3	360	740		SS-03	6 / 12	300	50 J	1,600 J	BH-31	4 - 6	3 / 3	170	74 J	240 J	TP-21	10.0 - 10.5
2-Methylphenol	340	710	--	--	0 / 3	--	--	--	--	0 / 12	--	--	--	--	--	1 / 3	140 *	59 J		TP-23	7.0 - 8.0
Di-n-butylphthalate	340	710	--	--	0 / 3	--	--	--	--	1 / 12	210	280 J		BH-29	10 - 15	0 / 3	--	--	--	--	--
Carbazole	340	710	--	--	1 / 3	410	880		SS-03	4 / 12	280	33 J	1,500 J	BH-31	4 - 6	2 / 3	97 *	43 J	67 J	TP-23	7.0 - 8.0
Pesticides (µg/kg)																					
beta-BHC	1.8	9.2	--	--	1 / 3	0.92	0.96 J		SS-03	0 / 12	--	--	--	--	--	0 / 3	--	--	--	--	--
delta-BHC	1.8	9.2	--	--	0 / 3	--	--	--	--	1 / 12	1.3 *	1.1 J		BH-33	2 - 4	0 / 3	--	--	--	--	--
4,4'-DDE	3.4	18	1.6 J	4.9 J	2 / 3	1.7	1.1 J	2.4 J	SS-01	4 / 12	3.4	1.8 J	8.3 J	BH-33	0 - 2	2 / 3	4.6	4.3 J	7.5 J	TP-23	7.0 - 8.0
4,4'-DDD	3.4	18	1.3 J	2.6 J	3 / 3	1.3	0.18 J	2.0 J	SS-03	2 / 12	3.2	3.8 J	7.4 J	BH-30	0 - 2	1 / 3	3.1	5.7 J		TP-23	7.0 - 8.0
4,4'-DDT	3.4	18	2.9 J	7.7 J	3 / 3	4.6	0.48 J	9.3	SS-01	8 / 12	10	4.3 J	43 J	BH-31	2 - 4	1 / 3	4.7	10 J		TP-22	5.0 - 7.0
Methoxychlor	18	92	1.8 J		1 / 3	6.3 *	0.89 J		SS-02	2 / 12	13 *	12 J	13 J	BH-33	2 - 4	0 / 3	--	--	--	--	--
Heptachlor Epoxide	1.8	9.2	0.62 J	2.0 J	2 / 3	1.00	0.69 J	1.4 J	SS-03	6 / 12	2.3	1.2 J	5.5 J	BH-31	4 - 6	0 / 3	--	--	--	--	--
Endosulfan I	1.8	9.2	--	--	0 / 3	--	--	--	--	9 / 12	25	1.5 J	220 J	BH-31	4 - 6	0 / 3	--	--	--	--	--
Endosulfan II	3.4	18	0.60 J	1.0 J	2 / 3	1.4 *	1.2 J	1.2 J	SS-01	5 / 12	4.6	1.9 J	31 J	BH-31	4 - 6	0 / 3	--	--	--	--	--
Endosulfan Sulfate	3.4	18	--	--	0 / 3	--	--	--	--	2 / 12	2.6	1.8 J	3.1 J	BH-33	2 - 4	0 / 3	--	--	--	--	--
Aldrin	1.8	9.2	--	--	2 / 3	1.1	0.50 J	2.0	SS-03	7 / 12	4.3	1.1 J	28 J	BH-31	4 - 6	1 / 3	1.6	2.7 J		TP-21	10.0 - 10.5
Dieldrin	3.4	18	2.1 J		0 / 3	--	--	--	--	1 / 12	2.6 *	2.5 J		BH-29	2 - 10	0 / 3	--	--	--	--	--
Endrin	3.4	18	--	--	3 / 3	1.8	0.35 J	3.4 J	SS-03	3 / 12	2.7	1.7 J	3.2 J	BH-34	2 - 4	1 / 3	2.3	3 J		TP-21	10.0 - 10.5
Endrin Aldehyde	3.4	18	--	--	0 / 3	--	--	--	--	3 / 12	2.9	2.6 J	4.6 J	BH-31	2 - 4	0 / 3	--	--	--	--	--
Endrin Ketone	3.4	18	--	--	1 / 3	3.0	5.6		SS-01	3 / 12	3.1	2.0 J	7.0 J	BH-33	2 - 4	0 / 3	--	--	--	--	--
alpha-Chlordane	1.8	9.2	0.27 J		2 / 3	0.62 *	0.41 J	0.56 J	SS-03	6 / 12	3.0	0.87 J	20 J	BH-31	4 - 6	1 / 3	1.6	2.7 J		TP-23	7.0 - 8.0
gamma-Chlordane	1.8	9.2	--	--	2 / 3	1.2	0.62 J	2.0	SS-03	4 / 12	1.4 *	1.0 J	1.2 J	BH-33	2 - 4	1 / 3	1.7	3.2 J		TP-23	7.0 - 8.0
PCBs (µg/kg)																					
Aroclor-1242	34	180	--	--	0 / 3	--	--	--	--	1 / 12	29	65 J		BH-32	10 - 12	0 / 3	--	--	--	--	--
Aroclor-1254	34	180	--	--	0 / 3	--	--	--	--	2 / 12	33	35 J	96 J	BH-32	10 - 12	0 / 3	--	--	--	--	--
Metals (mg/kg)																					
Aluminum	4.0	10.0	5,350 J	9,630 J	3 / 3	4,580	4,350 J	4,760 J	SS-02	12 / 12	4,790	3,240	6,220	BH-32	8 - 10	3 / 3	6,120	5,020	8,080	TP-23	7.0 - 8.0
Iron	1.1	3.7	4,640	8,350	3 / 3	20,500	7,020	41,200	SS-03	12 / 12	41,200	8,160	195,000	BH-33	2 - 4	3 / 3	60,100	22,700	85,600	TP-23	7.0 - 8.0
Calcium	7.6	26.6	949		3 / 3	899	570	1,460	SS-03	12 / 12	3,350	566	9,970	BH-33	2 - 4	3 / 3	8,020	4,620	13,800 J	TP-21	10.0 - 10.5
Magnesium	5.6	88.0	687	1,480	3 / 3	1,580	1,370	1,960	SS-03	12 / 12	2,120	1,160	3,510	BH-30	0 - 2	3 / 3	2,950	2,500	3,190	TP-23	7.0 - 8.0
Potassium	18.2	548	--	--	1 / 3	402	733		SS-03	12 / 12	640	318	1,000	BH-31	2 - 4	3 / 3	462	363	524	TP-21	10.0 - 10.5
Barium	0.2	1.2	9.3	32.0	3 / 3	40.6	22.2	61.0	SS-03	12 / 12	44.8	12.7 J	89.6 J	BH-30	0 - 2	3 / 3	146	73.1	221	TP-23	7.0 - 8.0
Manganese	0.1	1.0	32.0 J	206 J	3 / 3	177	99.4 J	263 J	SS-03	12 / 12	286	75.4	968	BH-33	2 - 4	3 / 3	457	254	583	TP-23	7.0 - 8.0
Beryllium	0.1	1.0	--	--	0 / 3	--	--	--	--	9 / 12	0.35	0.27	0.56	BH-33	2 - 4	2 / 3	0.30	0.35	0.40	TP-22	5.0 - 7.0
Antimony	3	10.8	--	--	0 / 3	--	--	--	--	11 / 12	9.2	3.3 J	22.8 J	BH-33	0 - 2	2 / 3	10.8	9.3 J	21.5	TP-21	10.0 - 10.5

TABLE 4-6 (Continued). SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM THE B&M LOCOMOTIVE SHOP DISPOSAL AREA B (1)

Analyte	Range of SQLs (2) Minimum	Range of SQLs (2) Maximum	Background Surface Soil Range of Values (4) Minimum	Background Surface Soil Range of Values (4) Maximum	Surface Soil Frequency of Detection (3)	Surface Soil Arithmetic Average	Surface Soil Range of Values (4) Minimum	Surface Soil Range of Values (4) Maximum	Surface Soil Maximum Location	Borehole Soil Frequency of Detection (3)	Borehole Soil Arithmetic Average	Borehole Soil Range of Values (4) Minimum	Borehole Soil Range of Values (4) Maximum	Borehole Soil Maximum Location	Borehole Soil Depth Interval (feet)	Test Pit Soil Frequency of Detection (3)	Test Pit Soil Arithmetic Average	Test Pit Soil Range of Values (4) Minimum	Test Pit Soil Range of Values (4) Maximum	Test Pit Soil Maximum Location	Test Pit Soil Depth Interval (feet)
Metals (mg/kg)																					
Arsenic	0.4	1.0	4.0 J	7.6 J	3 / 3	9.2	4.5 J	15.2 J	SS-03	12 / 12	13.6	4.7	48.0 J	BH-33	2 - 4	3 / 3	28.9	12.3	41.3 J	TP-21	10.0 - 10.5
Cadmium	0.3	0.5	--	--	0 / 3	--	--	--	--	2 / 12	0.5	1.2 J		BH-42 BH-43	2 - 4 2 - 4	0 / 3	--	--	--	--	--
Chromium	0.4	2.4	--	--	2 / 3	15.6	20.4 J	20.6 J	SS-01	12 / 12	30.8	11.1 J	94.7 J	BH-33	2 - 4	3 / 3	53.5	22.1 J	92.3 J	TP-23	7.0 - 8.0
Cobalt	0.3	2.2	--	--	2 / 3	3.5	3.9	5.3	SS-03	12 / 12	7.1	3.9	20.6	BH-33	2 - 4	3 / 3	10.9	5.0	17.3	TP-23	7.0 - 8.0
Copper	0.5	3.6	4.7 J	8.9 J	3 / 3	175	36.8 J	319 J	SS-03	12 / 12	889	65.8 J	2,110 J	BH-34	4 - 6	3 / 3	970	449 J	1,400 J	TP-23	7.0 - 8.0
Lead	0.2	6.0	102		2 / 3	164	38.2	451 J	SS-03	12 / 12	564	80.3 J	3,070 J	BH-31	2 - 4	3 / 3	711	268	960 J	TP-21	10.0 - 10.5
Mercury	0.05	0.12	--	--	0 / 3	--	--	--	--	4 / 12	0.07	0.06	0.47	BH-30	0 - 2	3 / 3	0.76	0.16	1.4	TP-21	10.0 - 10.5
Nickel	0.8	8.4	--	--	2 / 3	12.7	14.3	19.3	SS-03	9 / 12	28.1	17.0	93.5	BH-33	2 - 4	3 / 3	58.3	24.8 J	77.9 J	TP-23	7.0 - 8.0
Selenium	0.5	0.8	--	--	1 / 3	0.49	0.88		SS-03	11 / 11	1.4	0.51 J	2.9	BH-33	2 - 4	2 / 3	4.4	4.2 J	7.8	TP-23	7.0 - 8.0
Silver	0.7	1.2	--	--	0 / 3	--	--	--	--	7 / 12	2.2	1.2	11.1	BH-33	2 - 4	3 / 3	5.0	1.1	7.0	TP-23	7.0 - 8.0
Thallium	0.5	0.7	--	--	0 / 3	--	--	--	--	0 / 12	--	--	--	--	--	3 / 3	1.2	0.73 J	1.9 J	TP-23	7.0 - 8.0
Vanadium	0.5	2.4	7.2	13.7	3 / 3	9.1	7.6	11.3 J	SS-03	12 / 12	16.6	6.3 J	33.4 J	BH-33	2 - 4	3 / 3	22.2	11.0	41.1	TP-23	7.0 - 8.0
Zinc	0.7	1.2	18.4 J	46.6 J	3 / 3	86.8	43.9 J	127 J	SS-01	12 / 12	209	74.3 J	512 J	BH-34	4 - 6	3 / 3	397	196 J	661 J	TP-23	7.0 - 8.0
Soil Quality Parameters (mg/kg)																					
Cyanide - Not Detected																					
Total Petroleum Hydrocarbons	10	530	--	--	3 / 3	130	89	190	SS-03	12 / 12	403	15.5 J	2,500 J	BH-31	2 - 4	3 / 3	450	120	620	TP-23	7.0 - 8.0
Geotechnical Parameters (%)																					
Total Combustible Organics	--	--	--	--	1 / 1	6.4	6.4		SS-03	3 / 3	1.4	0.8	2.5	BH-29	2-10	NA	NA	NA	NA	NA	NA
Soil Moisture Content	--	--	--	--	1 / 1	4.2	4		SS-03	3 / 3	11	6.2	16	BH-32	10-12	NA	NA	NA	NA	NA	NA

NOTES:

1 Analytical data is presented in Appendix F.

2 SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.

3 Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.

4 Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
A single concentration is presented when only one positive detection has occurred.

5 Although summary data are presented, these analytes are not considered to be site-related as discussed in sections 2.3.2 and 4.2.1.

* - The calculated average is greater than the maximum value.

-- Analyte was not detected in samples from this grouping.

N- Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

TABLE 4-7. SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM THE OLD B&M OIL/SLUDGE RECYCLING AREA (1)

	Range of SQLs (2)		Background Surface Soil Range of Values (4)		Surface Soil					Borehole Soil					
					Frequency of Detection (3)	Arithmetic Average	Range of Values (4)		Maximum Location	Frequency of Detection (3)	Arithmetic Average	Range of Values (4)		Maximum Location	Depth Interval (feet)
Analyte	Minimum	Maximum	Minimum	Maximum			Minimum	Maximum				Minimum	Maximum		
Volatile Organics (µg/kg)															
Benzene	10	53	--	--	0 / 6	--	--	--	--	1 / 23	5 *	2 J		BH-40	8 - 10
Toluene	10	100	--	--	0 / 6	--	--	--	--	5 / 24	96	1 J	1,300 J	BH-40	10 - 12
Ethylbenzene	10	100	--	--	0 / 6	--	--	--	--	2 / 24	6	9 J	15 J	BH-40	10 - 12
Total Xylenes	10	53	--	--	0 / 6	--	--	--	--	1 / 23	8	58.5 J		BH-40	8 - 10
2-Butanone (5)	10	100	--	--	0 / 6	--	--	--	--	2 / 24	11	39 J	99 J	BH-40	10 - 12
Methylene Chloride (5)	10	53	7 J	36	0 / 6	--	--	--	--	0 / 23	--	--	--	--	--
Carbon Disulfide	10	53	--	--	1 / 6	5 *	2 J		SS-78	0 / 23	--	--	--	--	--
Semivolatile Organics (µg/kg)															
Naphthalene	330	13,000	--	--	1 / 6	180 *	43 J		SS-80	7 / 20	310	110 J	400 J	BH-39	2 - 4
2-Methylnaphthalene	330	13,000	--	--	1 / 6	180 *	77 J		SS-80	6 / 20	340	160 J	360 J	BH-39	2 - 4
Acenaphthylene	330	13,000	--	--	0 / 6	--	--	--	--	1 / 20	350 *	48 J		BH-41	0 - 2
Acenaphthene	330	13,000	--	--	0 / 6	--	--	--	--	1 / 20	340	350 J		BH-39	2 - 4
Fluorene	330	13,000	--	--	0 / 6	--	--	--	--	3 / 20	310	35 J	370 J	BH-39	2 - 4
Phenanthrene	330	13,000	--	--	2 / 6	200 *	140 J	180 J	SS-78	15 / 21	540	67 J	3,600 J	BH-39	2 - 4
Anthracene	330	13,000	--	--	1 / 6	170 *	19 J		SS-80	5 / 20	320	23 J	540 J	BH-39	2 - 4
Fluoranthene	330	13,000	--	--	3 / 6	210	71 J	400 J	SS-78	13 / 20	480	42 J	2,800 J	BH-39	2 - 4
Pyrene	330	13,000	--	--	3 / 6	200	56 J	300 J	SS-78	15 / 20	490	26 J	3,800 J	BH-39	2 - 4
Benzo(a)anthracene	330	13,000	--	--	3 / 6	160 *	39 J	140 J	SS-78	10 / 20	360	37 J	1,900 J	BH-39	2 - 4
Chrysene	330	13,000	--	--	3 / 6	180	79 J	200 J	SS-78	12 / 20	360	55 J	1,400 J	BH-39	2 - 4
Benzo(b)fluoranthene	330	13,000	--	--	3 / 6	170	61 J	200 J	SS-78	10 / 20	370	29 J	1,300 J	BH-39	2 - 4
Benzo(k)fluoranthene	330	13,000	--	--	3 / 6	140 *	39 J	110 J	SS-78	9 / 20	340	25 J	1,000 J	BH-39	2 - 4
Benzo(a)pyrene	330	13,000	--	--	3 / 6	150 *	51 J	80 J	SS-78	8 / 20	330	18 J	920 J	BH-39	2 - 4
Dibenz(a,h)anthracene	330	13,000	--	--	0 / 6	--	--	--	--	2 / 20	330 *	36 J	270 J	BH-39	2 - 4
Benzo(g,h,i)perylene	330	13,000	--	--	1 / 6	180 *	80 J		SS-80	2 / 20	330 *	99 J	210 J	BH-39	2 - 4
Indeno(1,2,3-cd)pyrene	330	13,000	--	--	1 / 6	180 *	55 J		SS-78	4 / 20	340	82 J	630 J	BH-39	2 - 4
Dibenzofuran	330	13,000	--	--	1 / 6	170 *	22 J		SS-80	5 / 20	320	41 J	380 J	BH-39	2 - 4
Carbazole	330	13,000	--	--	1 / 6	180 *	33 J		SS-78	2 / 20	350	160 J	480 J	BH-39	2 - 4
Pesticides (µg/kg)															
4,4'-DDE	3.3	20	1.6 J	4.9 J	1 / 6	3.4	12 J		SS-82	4 / 21	4.7	2.2 J	40 J	BH-40	10 - 12
4,4'-DDD	3.3	20	1.3 J	2.6 J	1 / 6	4.1	16 J		SS-82	2 / 21	2.4	1.7 J	5.8 J	BH-39	2 - 4
4,4'-DDT	3.3	20	2.9 J	7.7 J	1 / 6	2.2	3.1 J		SS-78	2 / 21	3.0	3.6 J	15 J	BH-39	2 - 4
Methoxychlor	17	100	1.8 J		0 / 6	--	--	--	--	3 / 21	23	12 J	210 J	BH-40	10 - 12
Heptachlor Epoxide	1.7	10	0.62 J	2.0 J	0 / 6	--	--	--	--	4 / 21	1.4	0.93 J	3.0 J	BH-39	2 - 4
Endosulfan I	1.7	10	--	--	1 / 6	2.1	8.4 J		SS-82	4 / 21	3.3	1.9 J	31 J	BH-40	10 - 12
Endosulfan II	3.3	20	0.60 J	1.0 J	1 / 6	2.7	7.5 J		SS-82	4 / 21	3.7	2.6 J	29 J	BH-40	10 - 12
Endosulfan Sulfate	3.3	20	--	--	0 / 6	--	--	--	--	3 / 21	2.5	2.0 J	8.2 J	BH-40	8 - 10
Aldrin	1.7	10	--	--	0 / 6	--	--	--	--	2 / 21	4.1	22 J	46 J	BH-40	10 - 12
Dieldrin	3.3	20	2.1 J		0 / 6	--	--	--	--	1 / 21	2.3	2.9 J		BH-44	2 - 5
Endrin	3.3	20	--	--	2 / 6	3.1	2.0 J	9.8 J	SS-82	7 / 21	5.2	2.0 J	32 J	BH-40	10 - 12
Endrin Aldehyde	3.3	20	--	--	0 / 6	--	--	--	--	6 / 21	6.4	2.4 J	48 J	BH-40	10 - 12
Endrin Ketone	3.3	20	--	--	2 / 6	2.6	2.8 J	5.9 J	SS-82	7 / 21	6.5	2.1 J	63 J	BH-40	10 - 12
alpha-Chlordane	1.7	10	0.27 J		1 / 6	1.6	5.2 J		SS-82	6 / 21	2.6	1.0 J	24 J	BH-40	10 - 12
gamma-Chlordane	1.7	10	--	--	1 / 6	1.6	5.1 J		SS-82	3 / 21	2.8	0.98 J	27 J	BH-40	10 - 12
PCBs (µg/kg)															
Aroclor-1260	33	200	--	--	0 / 6	--	--	--	--	1 / 21	27	110 J		BH-44	2 - 5
Metals (mg/kg)															
Aluminum	4.0	10.0	5,350 J	9,630 J	6 / 6	6,300	4,130	8,640 (4)	SS-82	21 / 21	5,490	3,510	8,030	BH-43	0 - 2
Iron	2.9	5.1	4,640	8,350	6 / 6	9,320	7,550 J	10,600 J	SS-81	21 / 21	9,720	3,540 J	42,100 J	BH-39	2 - 4
Calcium	16.1	27.7	949		6 / 6	996	616	1,530	SS-80	20 / 21	1,150	364 J	4,930	BH-39	2 - 4
Magnesium	7.7	88	687	1,480	6 / 6	2,410	1,950	2,940	SS-81	21 / 21	1,780	970	3,540	BH-39	2 - 4
Sodium	9.4	26.1	--	--	0 / 6	--	--	--	--	2 / 21	320	2,140	2,560	BH-40	10 - 12
Potassium	31.6	547.8	--	--	6 / 6	933	678	1,190	SS-83	21 / 21	751	443	1,620	BH-36	2 - 6

TABLE 4-7 (Continued). SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM THE OLD B&M OIL/SLUDGE RECYCLING AREA (1)

	Range of SQLs (2)		Background Surface Soil Range of Values (4)		Surface Soil					Borehole Soil					
					Frequency of Detection (3)	Arithmetic Average	Range of Values (4)		Maximum Location	Frequency of Detection (3)	Arithmetic Average	Range of Values (4)		Maximum Location	Depth Interval (feet)
Analyte	Minimum	Maximum	Minimum	Maximum			Minimum	Maximum				Minimum	Maximum		
Metals (continued) (mg/kg)															
Barium	0.4	1.6	9.3	32.0	6 / 6	25.0	14.1	38.7	SS-80	21 / 21	45.6	12.5	405	BH-39	2 - 4
Manganese	0.3	1.0	32.0 J	206 J	6 / 6	110	88.1 J	135 J	SS-82	21 / 21	118	44.2 J	613 J	BH-39	2 - 4
Beryllium	0.2	1.0	--	--	1 / 6	0.13	0.27		SS-82	5 / 21	0.17	0.19 J	0.29	BH-41	2 - 4
Antimony	3.0	10.8	--	--	1 / 6	3.6	14.1 J		SS-81	7 / 21	26.1	4.5 J	319 J	BH-40	10 - 12
Arsenic	0.3	1.0	4.0 J	7.6 J	6 / 6	8.8	6.6	10.8	SS-82	20 / 21	7.5	2.1	16.7	BH-39	2 - 4
Cadmium	0.3	1.2	--	--	0 / 6	--	--	--	--	2 / 21	0.27	1.2	1.2 J	BH-43	2 - 4
Chromium	1.0	2.4	--	--	4 / 6	13.6	15.6	18.1	SS-81	7 / 21	10.7	13.1 J	43.6	BH-39	2 - 4
Cobalt	0.5	2.2	--	--	5 / 6	3.7	3.3	4.8	SS-81	13 / 21	3.1	2.1 J	8.2	BH-39	2 - 4
Copper	0.8	3.6	4.7 J	8.9 J	6 / 6	18.0	7.0 J	41.1 J	SS-81	17 / 21	138	8.2	1,980 J	BH-39	2 - 4
Lead	0.2	6.0	102		6 / 6	82.6	10.8 J	362 J	SS-81	18 / 21	619	8.9 J	4,120 J	BH-40	10 - 12
Mercury	0.05	0.12	--	--	0 / 6	--	--	--	--	6 / 21	0.09	0.06	0.84	BH-39	2 - 4
Nickel	0.9	8.4	--	--	0 / 6	--	--	--	--	1 / 21	6.5	45.9		BH-39	2 - 4
Selenium	0.4	0.8	--	--	1 / 6	0.27	0.50		SS-78	8 / 21	0.51	0.48	1.6	BH-42	2 - 4
Thallium	0.4	0.7	--	--	0 / 6	--	--	--	--	3 / 21	0.31	0.46	0.92	BH-42	4 - 6
Vanadium	0.5	2.4	7.2	13.7	6 / 6	15.4	11.7	18.7	SS-82	21 / 21	12.2	6.5	24.0	BH-39	2 - 4
Zinc	0.7	1.2	18.4 J	46.6 J	6 / 6	51.0	23.7	133 J	SS-81	15 / 21	70.7	14.4 J	901 J	BH-39	2 - 4
Soil Quality Parameters (mg/kg)															
Cyanide - Not Detected															
Total Petroleum Hydrocarbons	10	2,300	--	--	4 / 6	100	56 J	330 J	SS-82	16 / 21	800	11 J	8,200 J	BH-40	10 - 12
Geotechnical Parameters (%)															
Total Combustible Organics	--	--	--	--	NA	NA	NA	NA	NA	4 / 4	2.7	0.44	7.4	BH-40	10 - 12
Soil Moisture Content	--	--	--	--	NA	NA	NA	NA	NA	4 / 4	15	4.8	21	BH-40	10 - 12

NOTES:

1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included. A single concentration is presented when only one positive detection has occurred.
5. Although summary data are presented, these analytes are not considered to be site-related as discussed in sections 2.3.2 and 4.2.1.

* - The calculated average is greater than the maximum value.

-- Analyte was not detected in samples from this grouping.

NA - Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

TABLE 4-8. SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM THE CONTAMINATED SOIL AREA (1)

Analyte	Range of SQLs (2) Minimum	Range of SQLs (2) Maximum	Background Surface Soil Range of Values (4) Minimum	Background Surface Soil Range of Values (4) Maximum	Surface Soil Frequency of Detection (3)	Surface Soil Arithmetic Average	Surface Soil Range of Values (4) Minimum	Surface Soil Range of Values (4) Maximum	Surface Soil Maximum Location
Volatile Organics (µg/kg)									
Acetone (5)	10	29	--	--	10 / 46	18	6 J	62 J	SS-43
Methylene Chloride (5)	10	22	7 J	36	34 / 46	79	6 J	450 J	SS-19
Chloroethane	10	12	--	--	4 / 46	10	23	79 J	SS-17
Semivolatile Organics (µg/kg)									
Naphthalene	340	12,000	--	--	28 / 46	1,300	97 J	8,500 J	SS-28
2-Methylnaphthalene	340	12,000	--	--	32 / 46	1,300	98 J	5,200 J	SS-28
Acenaphthylene	340	12,000	--	--	21 / 46	1,400 *	78 J	540	SS-14
Acenaphthene	340	12,000	--	--	3 / 45	1,400	100 J	8,000 J	SS-28
Fluorene	340	12,000	--	--	5 / 46	1,400	95 J	8,100 J	SS-28
Phenanthrene	340	12,000	--	--	39 / 46	2,200	99 J	48,000 J	SS-28
Anthracene	340	12,000	--	--	25 / 46	1,300	130 J	12,000 J	SS-28
Fluoranthene	340	12,000	--	--	42 / 46	2,500	140 J	40,000 J	SS-28
Pyrene	340	12,000	--	--	42 / 45	2,300	110 J	32,000 J	SS-28
Benzo(a)anthracene	340	12,000	--	--	32 / 45	1,700	140 J	18,000 J	SS-28
Chrysene	340	12,000	--	--	36 / 45	1,800	120 J	20,000 J	SS-28
Benzo(b)fluoranthene	340	12,000	--	--	39 / 45	2,600	130 J	28,000 J	SS-28
Benzo(a)pyrene	340	12,000	--	--	32 / 45	1,600	110 J	15,000 J	SS-28
Dibenz(a,h)anthracene	340	12,000	--	--	11 / 45	1,300	94 J	3,300 J	SS-28
Benzo(g,h,i)perylene	340	12,000	--	--	25 / 45	1,400	100 J	7,400 J	SS-28
Indeno(1,2,3-cd)pyrene	340	12,000	--	--	30 / 45	1,400	87 J	7,900 J	SS-28
Dibenzofuran	340	12,000	--	--	17 / 46	1,400	56 J	10,000 J	SS-28
Phenol	340	12,000	--	--	2 / 45	1,400 *	220 J	230 J	SS-21
2-Methylphenol	340	12,000	--	--	1 / 45	1,400 *	150 J		SS-21
4-Methylphenol	340	12,000	--	--	1 / 45	1,400 *	280 J		SS-21
2,4-Dimethylphenol	340	12,000	--	--	1 / 45	1,400 *	130 J		SS-21
Pentachlorophenol	830	30,000	--	--	9 / 46	4,500	140 J	75,000 J	SS-52
Di-n-butylphthalate	340	12,000	--	--	1 / 45	1,500	7,600 J		SS-21
Bis(2-ethylhexyl)phthalate	340	12,000	--	--	13 / 44	1,400	120 J	4,200 J	SS-47
Carbazole	340	12,000	--	--	15 / 46	1,400	87 J	8,900 J	SS-28
Pesticides (µg/kg)									
alpha-BHC	1.8	2.0	--	--	17 / 44	0.93	0.37 J	1.8 J	SS-48
beta-BHC	1.8	2.0	--	--	6 / 43	0.96	0.34 J	2.4 J	SS-33
gamma-BHC(Lindane)	1.8	2.0	--	--	11 / 44	0.99	0.21 J	5.3 J	SS-30
4,4'-DDE	3.4	3.9	1.6 J	4.9	41 / 45	8.1	1.7 J	22 J	SS-51
4,4'-DDD	3.4	3.9	1.3 J	2.6	46 / 46	14	1.1 J	150 J	SS-51
4,4'-DDT	3.4	3.9	2.9 J	7.7	44 / 46	370	4.4 J	16,000 J	SS-51
Methoxychlor	18	20	1.8 J		17 / 45	19	11 J	76 J	SS-26
Heptachlor	1.8	2.0	--	--	3 / 43	0.89 *	0.24 J	0.54 J	SS-17
Heptachlor Epoxide	1.8	2.0	0.62 J	2.0	21 / 44	1.4	0.74 J	7.8 J	SS-52
Endosulfan I	1.8	2.0	--	--	4 / 43	2.0	3.7 J	32 J	SS-52
Endosulfan II	3.4	3.9	0.60 J	1.0	20 / 43	1.9	0.40 J	4.2 J	SS-22
Endosulfan Sulfate	3.4	3.9	--	--	20 / 44	7.3	2.2 J	75 J	SS-52
Aldrin	1.8	2.0	--	--	42 / 46	2.2	0.23 J	8.1 J	SS-22
Dieldrin	3.4	3.9	2.1 J		10 / 43	2.9	2.5 J	17 J	SS-42
Endrin	3.4	3.9	--	--	30 / 44	4.0	0.38 J	12 J	SS-30
Endrin Aldehyde	3.4	3.9	--	--	12 / 43	2.7	2.5 J	15 J	SS-50
Endrin Ketone	3.4	3.9	--	--	31 / 44	7.9	0.86 J	63 J	SS-52
alpha-Chlordane	1.8	2.0	0.27 J		17 / 44	1.2	0.49 J	8.3	SS-25
gamma-Chlordane	1.8	2.0	--	--	35 / 46	3.1	0.41 J	11	SS-25
PCBs (µg/kg)									
None Detected									
Metals (mg/kg)									
Aluminum	9.0	10.4	5,350 J	9,630 J	46 / 46	6,190	2,320	13,700	SS-29

TABLE 4-8 (Continued). SUMMARY OF ANALYTES DETECTED IN SOIL SAMPLES FROM THE CONTAMINATED SOIL AREA (1)

Analyte	Range of SQLs (2) Minimum	Range of SQLs (2) Maximum	Background Surface Soil Range of Values (4) Minimum	Background Surface Soil Range of Values (4) Maximum	Surface Soil Frequency of Detection (3)	Surface Soil Arithmetic Average	Surface Soil Range of Values (4) Minimum	Surface Soil Range of Values (4) Maximum	Surface Soil Maximum Location
Metals (continued) (mg/kg)									
Iron	2.8	5.9	4,640	8,350	46 / 46	37,400	11,800	146,000	SS-44
Calcium	3.6	27.5	949		44 / 46	2,120	510 J	9,730	SS-17
Magnesium	10.3	91.1	687	1,480	46 / 46	2,560	682	6,630	SS-37
Potassium	271	566.8	--	--	19 / 46	616	309	2,460	SS-39
Barium	0.9	1.0	9.3	32.0	46 / 46	226	19.6	3,630	SS-45
Manganese	0.2	1.0	32.0 J	206	46 / 46	425	105 J	3,400 J	SS-24
Antimony	0.4	0.5	--	--	15 / 46	28.2	8.0 J	494 J	SS-25
Arsenic	7.5	11.1	4.0 J	7.6	46 / 46	25.8	5.8 J	233	SS-34
Cadmium	0.6	1.2	--	--	9 / 46	1.2	1.1 J	8.0	SS-45
Chromium	1.7	2.5	--	--	44 / 46	42.8	13.3	385 J	SS-21
Cobalt	1.9	2.2	--	--	45 / 46	6.9	3.2	15.2	SS-45
Copper	0.9	3.7	4.7 J	8.9	45 / 46	1,510	35.6	46,200	SS-59
Lead	0.5	13.8	102		46 / 46	1,310	69.1	10,800 J	SS-45
Mercury	0.11	0.12	--	--	28 / 46	0.43	0.12	2.5 J	SS-18
Nickel	3.8	8.7	--	--	34 / 46	32.4	12.4 J	329	SS-21
Selenium	0.6	0.7	--	--	17 / 46	0.72	0.70 J	3.9	SS-24
Silver	0.9	1.0	--	--	1 / 35	0.76	11.1		SS-59
Vanadium	0.3	2.5	7.2	13.7	46 / 46	16.8	6.6 J	48.8	SS-34
Zinc	0.9	1.2	18.4 J	46.6	46 / 46	443	29.4	4,170	SS-45
Soil Quality Parameters (mg/kg)									
Cyanide	0.5	0.6	--	--	6 / 46	0.33	0.57 J	0.81	SS-43
Total Petroleum Hydrocarbons	11	4,200	--	--	44 / 46	860	12	15,000	SS-43
Geotechnical Parameters (%)									
Total Combustible Organics	--	--	--	--	9 / 9	8.2	3.1	20	SS-22
Soil Moisture Content	--	--	--	--	9 / 9	9.6	6.2	13	SS-54

NOTES:

1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included. A single concentration is presented when only one positive detection has occurred.
5. Although summary data are presented, these analytes are not considered to be site-related as discussed in sections 2.3.2 and 4.2.1.

* - The calculated average is greater than the maximum value.

NA - Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

--Analyte was not detected in samples.

TABLE 4-9. HYDROGEOLOGIC GROUPINGS OF MONITORING WELLS THAT WERE SAMPLED IN CONJUNCTION WITH THE AREAS OF CONCERN

Area of Concern	Hydrogeological Relationship of Monitoring Well Locations			
	Upgradient	Downgradient	Source Area	Vicinity (1)
Background				
Shallow Overburden	MW-200S	None	None	None
Deep Overburden	MW-200D, OW-06(2)	None	None	None
Bedrock	MW-200B, OW-05	None	None	None
B&M Railroad Landfill				
Shallow Overburden	OW-36	None	MW-213S, MW-214S MW-215S	MW-1C (3)
Deep Overburden	OW-35	None	MW-213D, MW-214D, MW-215D	MW-1A, MW-1B, OW-50
Bedrock	OW-34	None	MW-213B, MW-214B, MW-215B	MW-01, OW-49
RSI Landfill				
Shallow Overburden	OW-26, OW-27	MW-210S, MW-211S, MW-212S OW-03	None	OW-08
Deep Overburden	OW-25	MW-211D, MW-212D OW-02	None	OW-07
Bedrock	MW-207B	MW-210B, MW-211B, MW-212B OW-01	None	None
B&M Locomotive Shop Disposal Area				
Area A				
Shallow Overburden	MW-204S	MW-206S	None	OW-40
Deep Overburden	MW-204D	MW-206D	None	OW-39
Bedrock	MW-204B	MW-206B	None	None
Area B				
Shallow Overburden	MW-204S	MW-205S	None	OW-40
Deep Overburden	MW-204D	MW-205D	None	OW-39
Bedrock	MW-204B	MW-205B	None	None
Old B&M Oil/Sludge Recycling Area				
Shallow Overburden	MW-201S	MW-202S, MW-203S	OW-42, OW-43	OW-19
Deep Overburden	MW-201D	MW-202D, MW-203D	OW-41	OW-18, OW-38
Bedrock	MW-201B	MW-202B, MW-203B, OW-37	None	OW-17
Asbestos Lagoons				
Shallow Overburden	MW-208S	OW-11, OW-12, OW-21	None	OW-14
Deep Overburden	MW-208D	OW-10, OW-20	None	OW-13
Bedrock	MW-208B	OW-09, MW-209B	None	None

NOTES:
1. "Vicinity" is defined as a well that is within the immediate area being investigated, although not hydrogeologically upgradient, downgradient, or within the potential source area
2. No sample was obtained from OW-06 during either sampling round because the well was dry
3. OW-51 was not included as this well is not considered downgradient of the B&M landfill because shallow overburden may be hydraulically connected to the pond

MW - designates new monitoring wells
OW - designates existing monitoring wells

TABLE 4-10. HYDROGEOLOGIC GROUPINGS OF GROUNDWATER-SCREENING LOCATIONS FOR THE AREAS OF CONCERN

Areas of Concern	Hydrogeological Relationship of Groundwater-Screening Locations			
	Upgradient	Source Area	Downgradient	Vicinity (1)
B&M Railroad Landfill				
Groundwater Screening	None	GW-41 through GW-50	None	None
RSI Landfill				
Groundwater Screening	None	None	GW-01 through GW-10	None
B&M Locomotive Shop Disposal Area A				
Groundwater Screening	None	None	GW-21 through GW-22	None
B&M Locomotive Shop Disposal Area B				
Groundwater Screening	None	GW-23 through GW-26, GW-28	None	GW-27
Old B&M Oil/Sludge Recycling Area				
Groundwater Screening	None	GW-14, GW-15	GW-12, GW-13, GW-16, GW-17, GW-18, GW-20	GW-19
Asbestos Lagoons				
Groundwater Screening	GW-31 through GW-34	None	GW-36 through GW-40	GW-35

NOTES:

1. "Vicinity" is defined as a location which is within the immediate area being investigated, but is not directly hydrogeologically (shallow groundwater) upgradient of, downgradient of, or within the potential source area

TABLE 4-11. VOLATILE ORGANICS DETECTED BY GROUNDWATER SCREENING (1,2)

Screening Location	Date Sampled	Sampling Depth (feet bgs)	1,1-DCE	cis 1,2-DCE	Benzene	PCE	m-Xylene	Vinyl Chloride (3)
B&M Railroad Landfill								
GW-45	10/04/93	4	5.0	---	---	---	---	---
RSI Landfill								
GW-02	09/28/93	9	61	43	2.6	---	---	1,600
GW-03	09/28/93	9	59	43	---	---	---	950
GW-06	09/28/93	9	2.7	3.0	0.4	---	---	8.0
GW-09	09/30/93	9	---	---	2.5	---	---	---
GW-10	09/30/93	3	1.7	---	---	---	---	---
B&M Locomotive Shop Disposal Area A								
GW-22	10/08/93	9	22	---	---	---	---	12
B&M Locomotive Shop Disposal Area B								
GW-27	10/08/93	9	1.3	---	---	---	---	---
Old B&M Oil/Sludge Recycling Area								
GW-11	09/29/93	9	12	---	---	---	---	---
GW-17	09/29/93	9	2.3	---	---	---	---	---
GW-18	10/05/93	9	9.2	---	---	---	---	11
GW-20	10/05/93	9	5.6	---	---	---	---	30
Asbestos Lagoons								
GW-31 (4)	10/06/93	9	---	---	3.9	---	---	---
GW-32 (4)	10/06/93	9	---	---	---	2.6	23	---
GW-39	10/07/93	9	0.9	---	---	---	---	---
GW-40	10/07/93	9	3.0	---	---	---	---	---

NOTES:

1. Groundwater screening data were generated in the field using groundwater headspace analysis by a gas chromatograph.
   The following samples were not analyzed due to insufficient volume: GW-38, GW-26, GW-47, GW-13
   The following samples were analyzed, although no compounds were detected:
   GW-01, GW-04, GW-05, GW-07, GW-08, GW-12, GW-14 through GW-16, GW-19, GW-21,
   GW-23 through GW-25, GW-28, GW-33 through GW-37, GW-41 through GW-44, GW-46,
   GW-48 through GW-50
2. All units are in $\mu g/l$
3. Vinyl chloride was not included in the initial calibration standard mix. The quantitation of vinyl chloride is based on a single standard injection and therefore is semi-quantitative
4. Concentrations are based on peak height. Several unknown peaks were observed in this sample

--- - Not detected
bgs - below ground surface
1,1-DCE - 1,1-Dichloroethene
cis 1,2-DCE - cis 1,2-Dichloroethene
PCE - Tetrachloroethene

TABLE 4-12. ANALYTES HISTORICALLY DETECTED IN GROUNDWATER ACROSS THE SITE (1)

Analyte	Frequency of Detection	Detects Per Flow Zone (2)	Concentration Range (µg/l)
Volatile Organics			
1,1-Dichloroethane	14/53	2 Shallow Overburden 9 Deep Overburden 3 Bedrock	14-17 3-16 4-20
trans-1,2-Dichloroethane	14/53	4 Shallow Overburden 7 Deep Overburden 3 Bedrock	2-6 2-12 5-15
Trichloroethene	12/53	2 Shallow Overburden 7 Deep Overburden 3 Bedrock	2-4 3-23 4-51
Chloroform	5/53	4 Deep Overburden 1 Bedrock	2-6 1
1,1,1-Trichloroethane	5/53	1 Shallow Overburden 3 Deep Overburden 1 Bedrock	3 1-2 4
Tetrachloroethene	5/53	2 Shallow Overburden 2 Deep Overburden 1 Bedrock	2-3 1-6 4
Chloroethane	4/53	2 Shallow Overburden 2 Deep Overburden	4-17 4-8
1,2-Dichloroethane	4/53	2 Deep Overburden 2 Bedrock	2-17 11-28
Benzene	4/53	1 Shallow Overburden 2 Deep Overburden 1 Bedrock	140 1 1
Total Xylenes	4/53	3 Shallow Overburden 1 Deep Overburden	7-80 5
1,1-Dichloroethene	3/53	1 Deep Overburden 2 Bedrock	2 2-7
Carbon Tetrachloride	1/53	1 Deep Overburden	7

TABLE 4-12 (Continued). ANALYTES HISTORICALLY DETECTED IN GROUNDWATER ACROSS THE SITE (1)

Analyte	Frequency of Detection	Detects Per Flow Zone (2)	Concentration Range ($\mu g/l$)
Volatile Organics (Continued)			
Chloromethane	1/53	1 Deep Overburden	6
Bromodichloromethane	1/53	1 Deep Overburden	2
Chlorobenzene	1/53	1 Bedrock	4
Ethylbenzene	1/53	1 Shallow Overburden	67
Semivolatile Organics			
Bis(2-ethylhexyl)phthalate	5/53	1 Deep Overburden 4 Bedrock	9 12-21
Di-n-octylphthalate	5/53	3 Deep Overburden 2 Bedrock	4-11 3-6
Naphthalene	2/53	2 Shallow Overburden	17-33
4-Methylphenol	2/53	1 Shallow Overburden 1 Bedrock	110 11
Di-n-butylphthalate	1/53	1 Shallow Overburden	20
Benzoic acid	1/53	1 Shallow Overburden	18
Pesticides and PCBs			
delta-BHC	1/53	1 Bedrock	0.08
PCBs	none		
Metals			
Antimony	1/53	1 Deep Overburden	27
Arsenic	17/53	9 Shallow Overburden 5 Deep Overburden 3 Bedrock	7-42 8-126 7-11
Barium	9/53	2 Shallow Overburden 4 Deep Overburden 3 Bedrock	79-80 71-134 71-79

TABLE 4-12 (Continued). ANALYTES HISTORICALLY DETECTED IN GROUNDWATER ACROSS THE SITE (1)

Analyte	Frequency of Detection	Detects Per Flow Zone (2)	Concentration Range (µg/l)
Metals (Continued)			
Cadmium	4/53	2 Shallow Overburden 2 Deep Overburden	5-6 6
Calcium	53/53	20 Shallow Overburden 22 Deep Overburden 11 Bedrock	3,650-40,900 14,400-71,500 22,500-153,000
Chromium	1/53	1 Deep Overburden	5
Cobalt	1/53	1 Deep Overburden	22
Copper	12/53	3 Shallow Overburden 5 Deep Overburden 4 Bedrock	3-15 7-27 4-12
Iron	33/53	12 Shallow Overburden 13 Deep Overburden 8 Bedrock	20-23,900 26-13,000 33.1-10,100
Lead	2/53	2 Bedrock	9-80
Magnesium	53/53	20 Shallow Overburden 22 Deep Overburden 11 Bedrock	360-13,200 1,750-10,500 684-21,000
Manganese	49/53	21 Shallow Overburden 26 Deep Overburden 6 Bedrock	19-2,130 31-3,096 42.8-1,500
Mercury	2/53	1 Shallow Overburden 1 Deep Overburden	0.3 0.2
Nickel	3/53	1 Shallow Overburden 1 Deep Overburden 1 Bedrock	204 7.6 9
Potassium	53/53	20 Shallow Overburden 22 Deep Overburden 11 Bedrock	878-10,700 1,160-16,100 1,480-33,400

TABLE 4-12 (Continued). ANALYTES HISTORICALLY DETECTED IN GROUNDWATER ACROSS THE SITE (1)

Analyte	Frequency of Detection	Detects Per Flow Zone (2)	Concentration Range (μg/l)
Metals (Continued)			
Selenium	2/53	1 Deep Overburden 1 Bedrock	6 45
Silver	1/53	1 Deep Overburden	4
Thallium	10/53	3 Shallow Overburden 5 Deep Overburden 2 Bedrock	11.4-23.8 8.7-38.7 9.1-384
Zinc	23/53	8 Shallow Overburden 10 Deep Overburden 5 Bedrock	69-903 44-657 38-1,260
Cyanide	5/53	1 Shallow Overburden 3 Deep Overburden 1 Bedrock	33 12-108 1,948

NOTES:
1. Summarized from the Phase 1A RI Report (CDM, 1987). The organic data presented includes all data as presented in the CDM report appendices (1987)
2. Flow zones with no detects are not listed

TABLE 4-13. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM BACKGROUND WELLS (MARCH/APRIL AND JULY 1995) (1)

	Range of SQLs (2)		Shallow Overburden		Deep Overburden		Bedrock			
			MW-200S		MW-200D		MW-200B		OW-05	
Analyte	Minimum	Maximum	March/April Round	July Round	March/April Round	July Round	March/April Round	July Round	March/April Round	July Round
Volatile Organics (µg/l)										
Carbon Disulfide	10		--	--	--	--	--	7 J	--	--
Semivolatile Organics (µg/l)										
None Detected										
Pesticides (µg/l)										
None Detected										
PCBs (µg/l)										
Aroclor-1260	0.05	0.06	0.02 J	--	--	--	0.01 J	--	--	--
Total Petroleum Hydrocarbons (mg/l)	1.0		--	--	--	--	1.7 J	--	--	--
Metals (µg/l)										
Aluminum (3)	25		--	--	1,440	--	--	--	--	--
Iron (3)	9.7	30.0	--	--	1,810	--	507	442 J	--	--
Calcium	10.0	14.5	32,300	22,700 J	12,300	11,100	10,400	12,700 J	3,870	2,840
Magnesium	5.4	15.0	9,230	3,410 J	2,100	1,660	2,270	2,100 J	1,430	1,000
Sodium	10.0	150	12,500	5,740 J	23,900	18,500	12,200	16,900 J	5,410	5,450 J
Potassium	10.0	30.8	3,170	--	2,280	1,970 J	1,940	2,730	455	--
Barium	1.0		14.9	27.1 J	10.6	--	--	--	7.9	--
Manganese	1.0	0.20	141	1,180 J	--	14.5	46.2	52.8 J	--	--
Arsenic (4)	2.7	8	--	--	45.2 J	48.5	--	7.9 J	--	--
Chromium	0.70		--	--	--	--	--	0.95	--	--
Copper	3		--	--	32.6 J	--	--	--	--	--
Lead (4)	3		--	--	12.5	--	--	--	--	--
Vanadium	2		--	--	3.6	2.7	--	--	--	--
Zinc	4		--	--	37.2 J	--	--	--	4.4	--
Water Quality Parameters (mg/l)										
Alkalinity (as $CaCO_3$)	1		75	NA	68	55	52	69	NA	NA
Hardness	NA		119	71 J	39	35	35	40 J	16	12
Chloride	0.5		25.7	NA	4.0	3.4	3.7	5.6	NA	NA
Nitrate/Nitrite as Nitrogen	0.01		0.20	NA	--	0.02	--	--	NA	NA
Sulfate	5		44	NA	28	23	11	--	NA	NA
Total Phosphorus	0.0050		0.028	NA	1.3	0.69	0.45	1.5	NA	NA
Cyanide (µg/l) - None Detected										
Biochemical Oxygen Demand	1.0		--	NA	11	13	4.2	5.9	NA	NA
Chemical Oxygen Demand	5		7	NA	--	16	7	5	NA	NA
Total Dissolved Solids	5		181	NA	206	125	66	124	NA	NA
Total Suspended Solids	0.5	0.6	0.4	NA	87	8.2	4.5	4.6	NA	NA
Total Organic Carbon	0.5		0.8	NA	4.4	5.2	2.0	2.2	NA	NA
Field Parameters										
pH			7.0	6.8	9.3	10	7.5	7.5	5.9	6.2
Specific Conductance (µmhos/cm)	NA		360	200	160	140	130	160	65	48
Redox Potential (mV)	NA		130	178	5	-92	-56	153	319	194
Dissolved Oxygen (mg/l)	NA		2.5	12	1.4	14	0.6	16	11	6.5
Turbidity (NTU)	NA		7	1	120	60	7	30	1	0
Temperature (C)	NA		6.3	18.2	10.1	16.1	9.5	15.0	7.3	12.1

NOTES:
1. Analytical data are presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Many results for these analytes were qualified as non-detected during data validation and evaluation. See Section 2.3.2 and 4.2.2 for discussion of the qualified data.
4. The Background Documentation for the Development of the Massachusetts Contingency Plan (MCP) Numerical Standards (MADEP, 1994) lists the background concentrations for arsenic and lead as 5.5 and 8.8 µg/l, respectively.

-- - Analyte was not detected in the sample.
NA - Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-14. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE B&M RAILROAD LANDFILL (MARCH/APRIL 1995) (1)

Analyte	Range of SQLs (2) Min.	Range of SQLs (2) Max.	Shallow Overburden Upgradient Value (3)	Shallow Overburden Frequency of Detection (4)	Shallow Overburden Range of Values (5) Min.	Shallow Overburden Range of Values (5) Max.	Shallow Overburden Maximum Location	Shallow Overburden Maximum Area (6)	Deep Overburden Upgradient Value (3)	Deep Overburden Frequency of Detection (4)	Deep Overburden Range of Values (5) Min.	Deep Overburden Range of Values (5) Max.	Deep Overburden Maximum Location	Deep Overburden Maximum Area (6)	Bedrock Upgradient Value (3)	Bedrock Frequency of Detection (4)	Bedrock Range of Values (5) Min.	Bedrock Range of Values (5) Max.	Bedrock Maximum Location	Bedrock Maximum Area (6)	Overall Maximum Value	Overall Maximum Location	Overall Maximum Area	Overall Maximum Flow Zone (7)
Volatile Organics (µg/l)																								
Toluene	10		--	1 /4	3 J		MW-213S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	3 J	MW-213S	S	SOB
Chlorobenzene	10		--	0 /4	--		--	--	--	1 /5	4 J		MW-213D	S	--	0 /4	--		--	--	4 J	MW-213D	S	DOB
Acetone	10		--	1 /4	15		MW-213S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	15	MW-213S	S	SOB
Trichloroethene	10		--	0 /4	--		--	--	--	1 /5	53		MW-213D	S	--	2 /4	22	50	MW-213B	S	53	MW-213D	S	DOB
1,1-Dichloroethene	10		--	0 /4	--		--	--	--	1 /5	8 J		MW-213D	S	--	2 /4	5 J	9 J	MW-213B	S	9 J	MW-213B	S	BR
1,2-Dichloroethene(total)	10		--	0 /4	--		--	--	--	1 /5	3 J		MW-213D	S	--	2 /4	3 J	5 J	OW-49	V	5 J	OW-49	V	BR
1,1-Dichloroethane	10		--	0 /4	--		--	--	--	2 /5	2 J	6 J	MW-213D	S	--	2 /4	5 J		MW-213B	S	6 J	MW-213D	S	DOB
1,2-Dichloroethane	10		--	0 /4	--		--	--	--	2 /5	3 J		MW-213D	S	--	2 /4	6 J	9 J	MW-213B	S	9 J	MW-213B	S	BR
													MW-214D	S										
Chloroform	10		--	0 /4	--		--	--	--	0 /5	--		--	--	--	2 /4	2 J	6 J	MW-215B	S	6 J	MW-215B	S	BR
Semivolatile Organics (µg/l)																								
Naphthalene	10		--	2 /4	41	54	MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	54	MW-214S	S	SOB
2-Methylnaphthalene	10		--	2 /4	3 J	10	MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	10	MW-214S	S	SOB
Acenaphthene	10		--	1 /4	7 J		MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	7 J	MW-214S	S	SOB
Fluorene	10		--	1 /4	6 J		MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	6 J	MW-214S	S	SOB
Phenanthrene	10		--	1 /4	8 J		MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	8 J	MW-214S	S	SOB
Dibenzofuran	10		--	1 /4	6 J		MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	6 J	MW-214S	S	SOB
4-Methylphenol	10		--	1 /4	4 J		MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	4 J	MW-214S	S	SOB
2,4-Dimethylphenol	10		--	1 /4	14		MW-213S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	14	MW-213S	S	SOB
Bis(2-ethylhexyl)phthalate	10		--	0 /4	--		--	--	--	0 /5	--		--	--	--	1 /4	9 J		MW-215B	S	9 J	MW-215B	S	BR
Carbazole	10		--	1 /4	6 J		MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	6 J	MW-214S	S	SOB
Pesticides (µg/l)																								
4,4'-DDT	0.005	0.006	--	0 /4	--		--	--	0.0009 J	0 /5	--		--	--	--	0 /4	--		--	--	0.0009 J	OW-35	U	DOB
Methoxychlor	0.03	0.06	--	1 /4	0.02 J		MW-213S	S	--	1 /5	0.008 J		MW-213D	S	--	0 /4	--		--	--	0.02 J	MW-213S	S	SOB
Heptachlor Epoxide	0.003	0.006	--	1 /4	0.0001 J		MW-215S	S	--	1 /5	0.001 J		MW-214D	S	--	0 /4	--		--	--	0.001 J	MW-214D	S	BR
Endosulfan Sulfate	0.005	0.01	--	1 /4	0.005 J		MW-213S	S	--	2 /5	0.0002 J	0.006 J	MW-214D	S	--	0 /4	--		--	--	0.005 J	MW-213S	S	SOB
Dieldrin	0.005	0.01	0.0006 J	2 /4	0.003 J	0.004 J	MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	0.004 J	MW-214S	S	SOB
alpha-Chlordane	0.003	0.006	--	1 /4	0.001 J		MW-213S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	0.001 J	MW-213S	S	SOB
gamma-Chlordane	0.003	0.006	--	1 /4	0.002 J		MW-214S	S	--	0 /5	--		--	--	--	1 /4	0.0007 J		OW-49	V	0.002 J	MW-214S	S	SOB
PCBs (µg/l)																								
Aroclor-1242	0.05	0.06	--	1 /4	0.04 J		MW-213S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	0.04 J	MW-213S	S	SOB
Aroclor-1248	0.05	0.06	--	1 /4	0.15		MW-214S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	0.15	MW-214S	S	SOB
Aroclor-1254	0.05	0.06	--	1 /4	0.02 J		MW-213S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	0.02 J	MW-213S	S	SOB
Aroclor-1260	0.05	0.06	0.06	1 /4	0.03 J		MW-213S	S	0.02 J	0 /5	--		--	--	--	0 /4	--		--	--	0.06	OW-36	U	SOB
Total Petroleum Hydrocarbons (mg/l)																								
None Detected																								
Metals (µg/l)																								
Aluminum (8)	25		--	1 /4	246		MW-01C	V	--	0 /5	--		--	--	--	1 /4	225		MW-214B	S	246	MW-01C	V	SOB
Iron (8)	30		--	3 /4	205	45,800	MW-214S	S	140	3 /5	83.8	324	MW-215D	S	--	3 /4	41.6	2,010	OW-49	V	45,800	MW-214S	S	SOB
Calcium	10.0		16,600	4 /4	8,230	88,500	MW-213S	S	34,100	5 /5	10,600	63,900	MW-213D	S	42,900	4 /4	13,700	75,900	OW-49	V	88,500	MW-213S	S	SOB
Magnesium	15.0		2,600	4 /4	1,330	18,600	MW-213S	S	10,600	5 /5	2,220	12,200	MW-213D	S	12,700	4 /4	2,140	18,300	OW-49	V	18,600	MW-213S	S	SOB
Sodium	10.0		8,910	4 /4	9,410	168,000	MW-213S	S	15,900	5 /5	11,700	65,400	MW-213D	S	13,100	4 /4	15,000	45,000	MW-213B	S	168,000	MW-213S	S	SOB
Potassium	200		1,640	4 /4	589	25,400	MW-213S	S	3,410	5 /5	1,190	9,550	MW-213D	S	1,590	4 /4	2,070	8,720	OW-49	V	25,400	MW-213S	S	SOB
Barium	1.0		12.1	4 /4	35.9	1,340	MW-213S	S	12.0	5 /5	5.9	73.2	MW-213D	S	--	4 /4	3.9	73.4	OW-49	V	1,340	MW-213S	S	SOB
Manganese	1.0		--	3 /4	218	5,420	MW-214S	S	156	5 /5	1.9	922	MW-213D	S	--	3 /4	47.3	1,260	OW-49	V	5,420	MW-214S	S	SOB
Antimony	3.0		4.7	0 /4	--		--	--	--	0 /5	--		--	--	--	0 /4	--		--	--	4.7	OW-36	U	SOB
Arsenic	8.0		--	1 /4	55.6 J		MW-214S	S	--	0 /5	--		--	--	--	1 /4	17.5 J		MW-214B	S	55.6 J	MW-214S	S	SOB
Chromium	5.0		--	0 /4	--		--	--	--	1 /5	16.2		OW-50	V	--	0 /4	--		--	--	16.2	OW-50	V	DOB
Cobalt	2.0		--	1 /4	6.3		MW-214S	S	--	2 /5	2.4	7.5	MW-213D	S	--	1 /4	3.3		OW-49	V	7.5	MW-214D	S	DOB
Copper	3.0		--	1 /4	57.8 J		MW-213S	S	8.3 J	1 /5	54.1 J		MW-215D	S	--	0 /4	--		--	--	57.8 J	MW-213S	S	SOB
Lead	3.0		--	2 /4	3.5	32.7	MW-213S	S	--	1 /5	8.5		MW-215D	S	--	0 /4	--		--	--	32.7	MW-213S	S	SOB
Nickel	10		--	1 /4	12.0		MW-213S	S	--	0 /5	--		--	--	--	0 /4	--		--	--	12.0	MW-213S	S	SOB
Zinc	4.0		--	2 /4	137 J	140 J	MW-214S	S	6.0	4 /5	3.8 J	35.9 J	MW-215D	RL-S	--	0 /4	--		--	--	140 J	MW-214S	S	SOB

TABLE 4-14 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE B&M RAILROAD LANDFILL (MARCH/APRIL 1995) (1)

	Range of SQLs (2)		Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
Analyte	Min.	Max.	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Value	Location	Area	Flow Zone (7)
Water Quality Parameters (mg/l)																								
Alkalinity (as $CaCO_3$)	1		29	1 / 1	97		MW-214S	S	28	1 / 1	40		MW-214D	S	22	1 / 1	54		MW-214B	S	97	MW-214S	S	SOB
Hardness	NA		52	4 / 4	26	298	MW-213S	S	129	5 / 5	36	210	MW-213D	S	159	4 / 4	43	265	OW-49	V	298	MW-213S	S	SOB
Chloride	0.5		7.1	1 / 1	17.4		MW-214S	S	78.1	1 / 1	98.7		MW-214D	S	95.0	1 / 1	9.1		MW-214B	S	98.7	MW-214D	S	DOB
Nitrate/Nitrite as Nitrogen	0.01		1.45	0 / 1	--		--	--	--	0 / 1	--		--	--	0.56	0 / 1	--		--	--	1.45	OW-36	U	SOB
Sulfate	5		11	0 / 1	--		--	--	36	1 / 1	28		MW-214D	S	31	1 / 1	21		MW-214B	S	28	MW-214D	S	DOB
Total Phosphorus	0.005		0.016	1 / 1	0.17		MW-214S	S	0.022	1 / 1	0.018		MW-214D	S	0.067	1 / 1	0.65		MW-214B	S	0.65	MW-214B	S	BR
Cyanide - None Detected																								
Biochemical Oxygen Deman	1.0		--	1 / 1	2.6		MW-214S	S	--	0 / 1	--		--	--	--	0 / 1	--		--	--	2.6	MW-214S	S	SOB
Chemical Oxygen Demand	5		--	0 / 1	--		--	--	6	0 / 1	--		--	--	14	0 / 1	--		--	--	14	OW-34	U	BR
Total Dissolved Solids	5		79	1 / 1	151		MW-214S	S	214	1 / 1	266		MW-214D	S	241	1 / 1	98		MW-214B	S	266	MW-214D	S	DOB
Total Suspended Solids	0.5		--	1 / 1	21		MW-214S	S	0.6	1 / 1	2.5		MW-214D	S	0.5	1 / 1	18		MW-214B	S	21	MW-214S	S	SOB
Total Organic Carbon	0.5		0.6	1 / 1	2.7		MW-214S	S	--	1 / 1	1.1		MW-214D	S	--	1 / 1	0.8		MW-214B	S	2.7	MW-214S	S	SOB
Field Parameters																								
pH	NA		6.4	4 / 4	5.1	7.5	MW-213S	S	6.9	5 / 5	5.9	6.8	MW-213D	S	7.1	4 / 4	6.2	8.1	MW-214B	S	8.1	MW-214B	S	BR
Specific Conductance (μmhos/cm)	NA		160	4 / 4	100	1,500	MW-213S	S	370	5 / 5	130	970	MW-213D	S	410	4 / 4	130	650	OW-49	V	1,500	MW-213S	S	SOB
Redox Potential (mV)	NA		220	4 / 4	-160	300	MW-01C	V	200	5 / 5	28	240	MW-01A	V	200	4 / 4	-130	200	MW-215B	S	300	MW-01C	V	SOB
Dissolved Oxygen (mg/l)	NA		5.3	4 / 4	0.0	4.4	MW-215S	S	1.4	5 / 5	0.2	4.6	MW-215D	S	3.0	4 / 4	0.4	3.2	MW-215B	S	5.3	OW-36	U	SOB
Turbidity (NTU)	NA		5	4 / 4	0	5	MW-213S	S	6	5 / 5	0	4	MW-213D	S	5	4 / 4	0	10	MW-214B	S	10	MW-214B	S	BR
Temperature (C)	NA		8.8	4 / 4	7.0	9.7	MW-214S	S	10.8	5 / 5	8.2	11.2	MW-213D	S	10.5	4 / 4	5.6	10.4	OW-49	V	11.2	MW-213D	S	DOB

NOTES:
1 Analytical data is presented in Appendix F.
2 SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3 Upgradient Wells: shallow overburden - OW-36; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
deep overburden - OW-35
bedrock - OW-34
4 Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
5 Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
A single concentration is presented when only one positive detection has occurred.
6 "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.
7 Flow Zones: SOB - shallow overburden
DOB - deep overburden
BR - bedrock
8 Many results for these analytes were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.
--- Analyte was not detected in samples from this grouping
N- Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-15. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE B&M RAILROAD LANDFILL (JULY 1995) (1)

Analyte	Range of SQLs (2)		Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Min.	Max.	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Value	Location	Area	Flow Zone (7)
Volatile Organics (µg/l)																								
Toluene	10		--	1 / 4	4 J		MW-213S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	4 J	MW-213S	S	SOB
Chlorobenzene	10		--	0 / 4	--		--	--	--	1 / 5	4 J		MW-213D	S	--	0 / 4	--		--	--	4 J	MW-213D	S	DOB
Trichloroethene	10		--	0 / 4	--		--	--	--	1 / 5	39		MW-213D	S	--	2 / 4	25	39	MW-213B	S	39	MW-213D	S	DOB
																						MW-213B	S	BR
1,1-Dichloroethene	10		--	0 / 4	--		--	--	--	1 / 5	4 J		MW-213D	S	--	2 / 4	3 J	4 J	MW-213B	S	4 J	MW-213D	S	DOB
																						MW-213B	S	BR
1,2-Dichloroethene(total)	10		--	0 / 4	--		--	--	--	1 / 5	3 J		MW-213D	S	--	2 / 4	3 J	8 J	OW-49	V	8 J	OW-49	V	BR
1,1-Dichloroethane	10		--	0 / 4	--		--	--	--	2 / 5	3 J	5 J	MW-213D	S	--	2 / 4	5 J		OW-49	V	5 J	MW-213D	S	DOB
													MW-214D	S					MW-213B	S		MW-214D	S	DOB
																						0W-49	V	BR
																						MW-213B	S	BR
1,2-Dichloroethane	10		--	0 / 4	--		--	--	--	2 / 5	3 J		MW-213D	S	--	2 / 4	6 J	8 J	OW-49	V	8 J	OW-49	V	BR
Chloroform	10		--	0 / 4	--		--	--	--	0 / 5	--		--	--	--	1 / 4	4 J		MW-215B	S	4 J	MW-215B	S	BR
Semivolatile Organics (µg/l)																								
Naphthalene	10		--	2 / 4	34	40	MW-213S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	40	MW-213S	S	SOB
2-Methylnaphthalene	10		--	2 / 4	3 J	8 J	MW-214S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	8 J	MW-214S	S	SOB
Acenaphthene	10		--	1 / 4	7 J		MW-214S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	7 J	MW-214S	S	SOB
Fluorene	10		--	2 / 4	1 J	6 J	MW-214S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	6 J	MW-214S	S	SOB
Phenanthrene	10		--	1 / 4	8 J		MW-214S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	8 J	MW-214S	S	SOB
Dibenzofuran	10		--	1 / 4	6 J		MW-214S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	6 J	MW-214S	S	SOB
2-Methylphenol	10		--	1 / 4	6 J		MW-213S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	6 J	MW-213S	S	SOB
4-Methylphenol	10		--	1 / 4	37		MW-213S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	37	MW-213S	S	SOB
Carbazole	10		--	1 / 4	3 J		MW-214S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	3 J	MW-214S	S	SOB
Pesticides (µg/l)																								
delta-BHC	0.003	0.004	--	0 / 4	--		--	--	--	0 / 5	--		--	--	--	2 / 4	0.001 J	0.002 J	MW-213B	S	0.002 J	MW-213B	S	BR
4,4'-DDE	0.005	0.006	--	0 / 4	--		--	--	--	0 / 5	--		--	--	--	1 / 4	0.002 J		MW-213B	S	0.002 J	MW-213B	S	BR
4,4'-DDD	0.005	0.006	--	1 / 4	0.03		MW-213S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.03	MW-213S	S	SOB
Endosulfan Sulfate	0.005	0.006	--	1 / 4	0.002 J		MW-214S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.002 J	MW-214S	S	SOB
Aldrin	0.003	0.004	--	1 / 4	0.01		MW-214S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.01	MW-214S	S	SOB
PCBs (µg/l)																								
None Detected																								
Total Petroleum Hydrocarbons (mg/l)																								
None Detected																								
Metals (µg/l)																								
Iron (8)	9.7		--	2 / 4	27,900	42,500	MW-214S	S	123	2 / 5	104	135	MW-214D	S	--	3 / 4	139	1,580	OW-49	V	42,500	MW-214S	S	SOB
Calcium	14.5		14,000 J	4 / 4	6,280	55,000	MW-213S	S	31,400 J	5 / 5	10,800	57,800	MW-213D	S	43,400 J	4 / 4	12,900	66,900	OW-49	V	66,900	OW-49	V	BR
Magnesium	5.4		2,040 J	4 / 4	953	14,000	MW-213S	S	9,160 J	5 / 5	2,200	10,400	MW-213D	S	12,000 J	4 / 4	1,910	15,500	OW-49	V	15,500	OW-49	V	BR
Sodium	150		9,060 J	4 / 4	8,210 J	219,000	MW-213S	S	15,100 J	5 / 5	13,700 J	79,400	MW-213D	S	13,500 J	4 / 4	14,000	66,500	MW-213B	S	219,000	MW-213S	S	SOB
Potassium	30.8		1,640 J	3 / 4	946 J	27,200 J	MW-213S	S	2,910	5 / 5	1,310	7,420 J	MW-213D	S	1,560	4 / 4	1,860 J	7,300 J	OW-49	V	27,200 J	MW-213S	S	SOB
Barium	0.20		9.7 J	2 / 4	137	2,000	MW-213S	S	10.5	2 / 5	36.7	70.3	MW-213D	S	--	2 / 4	13.4	67.5 J	OW-49	V	2,000	MW-213S	S	SOB
Manganese	0.20		--	4 / 4	12.5	4,040	MW-214S	S	306	4 / 5	182	888	OW-50	V	--	4 / 4	43.8	1,210	OW-49	V	4,040	MW-214S	S	SOB
Arsenic	2.7		--	2 / 4	3.1	39.7	MW-214S	S	--	0 / 5	--		--	--	3.8	2 / 4	7.5	19.6	MW-214B	S	39.7	MW-214S	S	SOB
Chromium	0.70		--	1 / 4	5.4		MW-213S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	5.4	MW-213S	S	SOB
Cobalt	0.50		--	2 / 4	2.3	3.6	MW-214S	S	--	3 / 5	1.4	5.7	MW-213D	S	--	2 / 4	1.7	3.7	OW-49	V	5.7	MW-213D	S	DOB
Lead	1.6		--	3 / 4	1.9	21.7	MW-213S	S	--	0 / 5	--		--	--	--	1 / 4	1.9		MW-215B	S	21.7	MW-213S	S	SOB
Nickel	2.4		--	1 / 4	21.8		MW-213S	S	--	2 / 5	3.4	4.0	MW-213D	S	--	2 / 4	2.8	3.3	OW-49	V	21.8	MW-213S	S	SOB
Vanadium	0.60		--	2 / 4	0.86	2.5	MW-213S	S	--	0 / 5	--		--	--	--	1 / 4	0.65		MW-214B	S	2.5	MW-213S	S	SOB
Zinc	1.2		--	2 / 4	106	347	MW-213S	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	347	MW-213S	S	SOB

TABLE 4-15 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE B&M RAILROAD LANDFILL (JULY 1995) (1)

	Shallow Overburden									Deep Overburden						Bedrock						Overall Maximum			
Analyte	Range of SQLs (2) Min.	Range of SQLs (2) Max.	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6	Value	Location	Area	Flow Zone (7)
Water Quality Parameters (mg/l)																								
Alkalinity (as $CaCO_3$)	1		NA	2 / 2	6.00	105	MW-214S	S	NA	2 / 2	33	36	MW-214D	S	NA	2 / 2	40	53	MW-214B	S	105	MW-214S	S	SOB
Hardness	NA		43 J	4 / 4	20	195	MW-213S	S	116 J	5 / 5	36	187	MW-213D	S	158 J	4 / 4	40	231	OW-49	V	231	OW-49	V	BR
Chloride	0.5		NA	2 / 2	16.4	33.8	MW-215S	S	NA	2 / 2	59.3	97.6	MW-214D	S	NA	2 / 2	8.8	26.5	MW-215B	S	97.6	MW-214D	S	DOB
Nitrate/Nitrite as Nitrogen	0.01		NA	1 / 2	3.10		MW-215S	S	NA	1 / 2	3.20		MW-215D	S	NA	1 / 2	0.40	0.40	MW-215B	S	3.20	MW-215D	S	DOB
Sulfate	5		NA	1 / 2	13		MW-215S	S	NA	2 / 2	16	26	MW-214D	S	NA	2 / 2	14	15	MW-215B	S	26	MW-215D	S	DOB
Total Phosphorus	0.0050		NA	2 / 2	0.010	0.24	MW-214S	S	NA	1 / 2	0.014		MW-215D	S	NA	2 / 2	0.033	0.65	MW-214B	S	0.65	MW-214B	S	BR
Cyanide (µg/l)	--																							
Biochemical Oxygen Demand	1.0		NA	1 / 2	2.6		MW-214S	S	NA	0 / 2	--		--	--	NA	0 / 2	--		--	--	2.6	MW-214S	S	SOB
Chemical Oxygen Demand	5		NA	0 / 2	--		--	--	NA	0 / 2	--		--	--	NA	0 / 2	--		--	--	--	--	--	--
Total Dissolved Solids	5		NA	2 / 2	137	142	MW-214S	S	NA	2 / 2	262	322	MW-214D	S	NA	2 / 2	110	123	MW-215B	S	322	MW-214D	S	DOB
Total Suspended Solids	0.5		NA	1 / 2	47		MW-214S	S	NA	1 / 2	0.5		MW-214D	S	NA	1 / 2	3.3		MW-214B	S	47	MW-214S	S	SOB
Total Organic Carbon	0.5		NA	1 / 2	2.1		MW-214S	S	NA	1 / 2	0.9 J		MW-214D	S	NA	1 / 2	0.9		MW-215B	S	2.1	MW-214S	S	SOB
Field Parameters																								
pH	NA		4.8	4 / 4	4.9	6.9	MW-213S	S	7.4	5 / 5	5.7	6.6	MW-213D	S	7.4	4 / 4	6.0	8.3	MW-215B	S	8.3	MW-215B	S	BR
Specific Conductance (µmhos/cm)	NA		110	4 / 4	94	1,700	MW-213S	S	420	5 / 5	150	910	MW-213D	S	470	4 / 4	170	1,200	OW-49	V	1,700	MW-213S	S	SOB
Redox Potential (mV)	NA		136	4 / 4	-150	378	MW-215S	S	25.2	5 / 5	-39	259	MW-215D	S	7.0	4 / 4	0.5	49.8	OW-49	V	378	MW-215S	S	SOB
Dissolved Oxygen (mg/l)	NA		7.9	4 / 4	0.5	12	MW-213S	S	0.3	5 / 5	0.6	11	MW-213D	S	2.2	4 / 4	0.5	14	OW-49	V	14	OW-49	V	BR
Turbidity (NTU)	NA		0	4 / 4	0		MW-214S	S	0	5 / 5	0		MW-213D	S	0	4 / 4	0		MW-214B	S	0	MW-214S	S	SOB
																						MW-213D	S	DOB
																						MW-214B	S	BR
Temperature (C)	NA		14.2	4 / 4	10.4	15.4	MW-214S	S	13.8	5 / 5	10.9	15.9	MW-213D	S	14.3	4 / 4	12.9	14.6	MW-214B	S	15.9	MW-213D	S	DOB

NOTES:

1 Analytical data is presented in Appendix F.

2 SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.

3 Upgradient Wells: shallow overburden - OW-36; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
deep overburden - OW-35
bedrock - OW-34

4 Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.

5 Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
A single concentration is presented when only one positive detection has occurred.

6 "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.

7 Flow Zones: SOB - shallow overburden
DOB - deep overburden
BR - bedrock

8 Many results for this analyte were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.

--- Analyte was not detected in samples from this grouping

N- Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-16. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE RSI LANDFILL (MARCH/APRIL 1995) (1)

Analyte	Range of SQLs (2) Min.	Range of SQLs (2) Max.	Shallow Overburden: Upgradient Range of Values (3) Min.	Shallow Overburden: Upgradient Range of Values (3) Max.	Shallow Overburden: Frequency of Detection (4)	Shallow Overburden: Range of Values (5) Min.	Shallow Overburden: Range of Values (5) Max.	Shallow Overburden: Maximum Location	Shallow Overburden: Maximum Area (6)	Deep Overburden: Upgradient Value (3)	Deep Overburden: Frequency of Detection (4)	Deep Overburden: Range of Values (5) Min.	Deep Overburden: Range of Values (5) Max.	Deep Overburden: Maximum Location	Deep Overburden: Maximum Area (6)	Bedrock: Upgradient Value (3)	Bedrock: Frequency of Detection (4)	Bedrock: Range of Values (5) Min.	Bedrock: Range of Values (5) Max.	Bedrock: Maximum Location	Bedrock: Maximum Area (6)	Overall Maximum: Value	Overall Maximum: Location	Overall Maximum: Area	Overall Maximum: Flow Zone (7)
Volatile Organics (µg/l)																									
Benzene		10	--	--	1 / 5	345		OW-08	V	--	0 / 4	--		--	--	--	0 / 4	--		--	--	350	OW-08	V	SOB
Total Xylenes		10	--	--	1 / 5	10 J		OW-08	V	--	0 / 4	--		--	--	--	0 / 4	--		--	--	10 J	OW-08	V	SOB
Chlorobenzene		10	--	--	1 / 5	3 J		MW-210S	D	--	0 / 4	--		--	--	--	1 / 4	3 J		OW-01	D	3 J	MW-210S	D	SOB
																							OW-01	D	BR
Tetrachloroethene		10	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	3 J	0 / 4	--		--	--	3 J	MW-207B	U	BR
Trichloroethene		10	--	--	0 / 5	--		--	--	--	1 / 4	23		OW-07	V	3 J	1 / 4	5 J		OW-01	D	23	OW-07	V	DOB
1,1,1-Trichloroethane		10	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	3 J	0 / 4	--		--	--	3 J	MW-207B	U	BR
1,1-Dichloroethene		10	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	2 J	0 / 4	--		--	--	2 J	MW-207B	U	BR
1,2-Dichloroethene(total)		10	--	--	0 / 5	--		--	--	--	1 / 4	8 J		OW-07	V	--	0 / 4	--		--	--	8 J	OW-07	V	DOB
1,1-Dichloroethane		10	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	2 J	0 / 4	--		--	--	2 J	MW-207B	U	BR
1,2-Dichloroethane		10	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	6 J	2 / 4	2 J	3 J	MW-212B	D	6 J	MW-207B	U	BR
Semivolatile Organics (µg/l)																									
Bis(2-ethylhexyl)phthalate		10	--	--	0 / 5	--		--	--	4 J	0 / 4	--		--	--	--	0 / 4	--		--	--	4 J	OW-25	U	DOB
Pesticides (µg/l)																									
delta-BHC	0.003	0.004	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	--	1 / 4	0.0004 J		OW-01	D	0.0004 J	OW-01	D	BR
gamma-BHC(Lindane)	0.004	0.005	--	--	0 / 5	--		--	--	--	1 / 4	0.003		MW-211D	D	--	0 / 4	--		--	--	0.003	MW-211D	D	DOB
4,4'-DDT	0.005	0.006	--	--	1 / 5	0.001 J		MW-212S	D	--	0 / 4	--		--	--	--	0 / 4	--		--	--	0.001 J	MW-212S	D	SOB
Methoxychlor	0.03	0.04	0.008 J		2 / 5	0.007 J	0.01 J	MW-210S	D	--	0 / 4	--		--	--	--	0 / 4	--		--	--	0.01 J	MW-210S	D	SOB
Heptachlor Epoxide	0.003	0.004	--	--	1 / 5	0.0004 J		OW-03	D	--	2 / 4	0.0002 J	0.0003 J	MW-212D	D	--	1 / 4	0.002 J		OW-01	D	0.002 J	OW-01	D	DOB
Endosulfan II	0.005	0.006	--	--	1 / 5	0.008		MW-211S	D	--	1 / 4	0.01		MW-211D	D	--	0 / 4	--		--	--	0.01	MW-211D	D	DOB
														OW-07	V										
Endosulfan Sulfate	0.005	0.006	0.004 J		1 / 5	0.002 J		MW-211S	D	0.001	3 / 4	0.0002 J	0.004 J	MW-211D	D	--	1 / 4	0.0006 J		MW-210B	D	0.004 J	MW-211D	D	DOB
																							OW-26	U	SOB
																							OW-27	U	SOB
Aldrin	0.003	0.004	0.002 J		1 / 5	0.0004 J		OW-03	D	--	1 / 4	0.002 J		OW-07	V	--	0 / 4	--		--	--	0.002 J	OW-07	V	DOB
																							OW-27	U	SOB
Dieldrin	0.005	0.006	--	--	1 / 5	0.0002 J		MW-212S	D	--	3 / 4	0.0005 J	0.001 J	MW-211D	D	--	0 / 4	--		--	--	0.001 J	MW-211D	D	DOB
Endrin	0.005	0.006	0.0002 J		0 / 5	--		--	--	--	0 / 4	--		--	--	--	0 / 4	--		--	--	0.0002 J	OW-26	U	SOB
Endrin Aldehyde	0.008	0.009	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	--	1 / 4	0.0006 J		MW-212B	D	0.0006 J	MW-212B	D	BR
Endrin Ketone	0.006	0.007	0.0005 J		0 / 5	--		--	--	--	0 / 4	--		--	--	--	0 / 4	--		--	--	0.0005 J	OW-27	U	SOB
gamma-Chlordane	0.003	0.004	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	--	1 / 4	0.0005 J		OW-01	D	0.0005 J	OW-01	D	BR
PCBs (µg/l)																									
Aroclor-1232		0.05	--	--	0 / 5	--		--	--	--	1 / 4	0.05 J		OW-07	V	--	0 / 4	--		--	--	0.05 J	OW-07	V	BR
Aroclor-1260		0.05	--	--	4 / 5	0.01 J		MW-210S	D	--	3 / 4	0.006 J	0.08	MW-212D	D	--	1 / 4	0.08		OW-01	D	0.08	MW-212D	D	DOB
																							OW-01	D	BR
Metals (µg/l)																									
Aluminum (8)		25	--	--	0 / 5	--		--	--	--	1 / 4	210		OW-07	V	--	0 / 4	--		--	--	210	OW-07	V	DOB
Iron (8)		30.0	30.4	1,350	5 / 5	2,830	63,500	MW-211S	D	33.0	4 / 4	987	58,500	MW-211D	D	130	2 / 4	117	979	MW-212B	D	63,500	MW-211S	D	SOB
Calcium		10.0	20,800	25,400	5 / 5	11,200	56,600	MW-211S	D	359,000	4 / 4	18,400	96,400	MW-211D	D	--	4 / 4	46,500	78,900	OW-01	D	359,000	OW-25	U	DOB
Magnesium		15.0	1,530	2,030	5 / 5	1,840	15,200	OW-08	V	41,600	4 / 4	2,620	16,500	MW-211D	D	134,000	4 / 4	4,270	8,610	OW-01	D	134,000	MW-207B	U	BR
Sodium		10.0	128,000	233,000	5 / 5	14,000	58,700	MW-212S	D	--	4 / 4	33,100	485,000	OW-07	V	25.8	4 / 4	8,230	71,700	MW-212B	D	485,000	OW-07	V	DOB
Potassium		200	4,870	8,910	5 / 5	2,500	12,100	MW-211S	D	67,900	4 / 4	3,610	20,000	MW-211D	D	37,300	4 / 4	2,210	8,450	MW-212B	D	67,900	OW-25	U	DOB
Barium		1.0	7.6	8.8	5 / 5	24.3	83.0	MW-211S	D	324	4 / 4	24.5	83.2	MW-211D	D	58.6	2 / 4	8.2	28.7	MW-212B	D	324	OW-25	U	DOB
Manganese		1.0	11.7	205	5 / 5	650	2,440	MW-210S	D	3,330	4 / 4	1,100	6,400	MW-211D	D	45.5	3 / 4	234	2,690	MW-212B	D	6,400	MW-211D	D	DOB
Arsenic		8.0	16.2	36.1	3 / 5	13.3 J	141	MW-211S	D	--	2 / 4	8.1	345	MW-211D	D	--	0 / 4	--		--	--	345	MW-211D	D	DOB
Chromium		5	--	--	0 / 5	--		--	--	--	1 / 4	20.6 J		OW-07	V	--	0 / 4	--		--	--	20.6 J	OW-07	V	DOB
Cobalt		2.0	--	--	3 / 5	3.1	6.6	MW-210S	D	5.8	2 / 4	2.3	12.2	MW-211D	D	--	0 / 4	--		--	--	12.2	MW-211D	D	DOB
Copper		3	3.9	5.9	0 / 5	--		--	--	--	1 / 4	34.7 J		OW-07	V	4.1 J	0 / 4	--		--	--	34.7 J	OW-07	V	DOB
Lead		3.0	--	--	2 / 5	2.4 J	8.8 J	MW-211S	D	--	2 / 4	6.7 J	25.2	OW-07	V	--	1 / 4	3.1 J		MW-210B	D	25.2	OW-07	V	DOB
Nickel		10	--	--	0 / 5	--		--	--	--	1 / 4	14.2	14.2	OW-07	V	--	0 / 4	--		--	--	14.2	OW-07	V	DOB
Selenium		5.0	--	--	2 / 5	4.2 J	5.6 J	MW-211S	D	--	0 / 4	--		--	--	--	0 / 4	--		--	--				
Silver		3	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	25.8 J	0 / 4	--		--	--	25.8	MW-207B	U	BR
Thallium		8	--	--	0 / 5	--		--	--	9.0 J	1 / 4	8.9 J		MW-211D	D	--	0 / 4	--		--	--	9.0 J	OW-25	U	DOB
Zinc		4	--	--	1 / 5	4.0J		MW-210S	D	--	1 / 4	35.4		OW-07	V	--	0 / 4	--		--	--	35.4	OW-07	V	DOB

TABLE 4-16 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE RSI LANDFILL (MARCH/APRIL 1995) (1)

			Shallow Overburden							Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient Range of Values (3)		Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Min.	Max.	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
Total Petroleum Hydrocarbons (mg/l)																									
None Detected																									
Water Quality Parameters (mg/l)																									
Alkalinity (CaCO3)		NA	NA		NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Hardness		NA	58	72	5 / 5	36	181	OW-08	V	1,070	4 / 4	57	309	MW-211D	D	5,200	4 / 4	134	232	OW-01	D	5,200	MW-207B	U	BR
Chloride		NA	NA		NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Nitrate/Nitrite as Nitrogen		NA	NA		NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Sulfate		NA	NA		NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Total Phosphorus		NA	NA		NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Cyanide (µg/l)		10.0	--	--	0 / 2	--		--	--	16.5 J	0 / 1	--		--	--	112	0 / 1	--		--	--	112	MW-207B	U	BR
Biochemical Oxygen Demand		NA	NA		NA	NA		NA	NA	NA	NA	NA		--	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Chemical Oxygen Demand		NA	NA		NA	NA		NA	NA	NA	NA	NA		--	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Total Dissolved Solids		NA	NA		NA	NA		NA	NA	NA	NA	NA		--	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Total Suspended Solids		NA	NA		NA	NA		NA	NA	NA	NA	NA		--	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Total Organic Carbon		NA	NA		NA	NA		NA	NA	NA	NA	NA		--	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
Field Parameters																									
pH		NA	7.5	8.7	5 / 5	6.1	7.0	OW-08	V	7.0	4 / 4	6.3	7.0	OW-07	V	6.7	4 / 4	6.9	7.7	MW-211B	D	8.7	OW-26	U	SOB
Specific Conductance (µmhos/cm)		NA	650	1,500	5 / 5	420	630	MW-211S	D	26,000	4 / 4	460	1,300	OW-07	V	19,000	4 / 4	330	1,100	MW-212B	D	26,000	OW-25	U	DOB
Redox Potential (mV)		NA	-110	37.6	5 / 5	-83.0	81.0	MW-210S	D	84.5	4 / 4	1.2	85	MW-212D	D	140	4 / 4	-40	250	MW-211B	D	250	MW-211B	D	BR
Dissolved Oxygen (mg/l)		NA	0.2	1.0	5 / 5	0.1	11	OW-08	V	0.3	4 / 4	0.1	1.3	MW-212D	D	1.4	4 / 4	0.6	3.7	MW-211B	D	11	OW-08	V	SOB
Turbidity (NTU)		NA	0	1	5 / 5	0	4	OW-03	D	0	4 / 4	0	2	MW-212D	D	3	4 / 4	1	4	OW-01	D	4	OW-03	D	SOB
																							OW-01	D	BR
Temperature (C)		NA	10.4	10.6	5 / 5	5.7	8.5	OW-08	V	11.0	4 / 4	8.8	10.2	OW-07	V	12.2	4 / 4	9.5	10.9	MW-212B	D	12.2	MW-207B	U	BR

NOTES:
1 Analytical data is presented in Appendix F.
2 SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3 Upgradient Wells: shallow overburden - OW-26/27; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
deep overburden - OW-25
bedrock - MW-207B
4 Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
5 Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
A single concentration is presented when only one positive detection has occurred.
6 "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.
7 Flow Zones: SOB - shallow overburden
DOB - deep overburden
BR - bedrock
8 Many results for these analytes were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.
--- Analyte was not detected in samples from this grouping
N- Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-17. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE RSI LANDFILL (JULY 1995) (1)

			Shallow Overburden							Deep Overburden						Bedrock						Overall Maximum			
Analyte	Range of SQLs (2) Min.	Range of SQLs (2) Max.	Upgradient Range of Values (3) Min.	Upgradient Range of Values (3) Max.	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Value	Location	Area	Flow Zone (7)
Volatile Organics (µg/l)																									
Benzene	10		--		1 / 5	350		OW-08	V	--	0 / 4	--		--	--	--	0 / 4	--		--	--	350	OW-08	V	SOB
Total Xylenes	10		--		1 / 5	13		OW-08	V	--	0 / 4	--		--	--	--	0 / 4	--		--	--	13	OW-08	V	SOB
Tetrachloroethene	10		--		0 / 5	--		--	--	--	0 / 4	--		--	--	3 J	0 / 4	--		--	--	3 J	MW-207B	U	BR
1,1,2,2-Tetrachloroethane	10		--		0 / 5	--		--	--	--	1 / 4	5 J		MW-212D	D	--	0 / 4	--		--	--	5 J	MW-212D	D	DOB
Trichloroethene	10		--		0 / 5	--		--	--	--	1 / 4	21		OW-07	V	3 J	1 / 4	5 J		OW-01	D	21	OW-07	V	DOB
1,2-Dichloroethene(total)	10		--		0 / 5	--		--	--	--	1 / 4	4 J		OW-07	V	--	0 / 4	--		--	--	4 J	OW-07	V	DOB
1,2-Dichloroethane	10		--		0 / 5	--		--	--	--	0 / 4	--		--	--	6 J	1 / 4	3 J		MW-212B	D	6 J	MW-207B	U	BR
Semivolatile Organics (µg/l)																									
1,4-Dichlorobenzene	10		--		1 / 5	3 J		OW-08	V	--	0 / 4	--		--	--	--	0 / 4	--		--	--	3 J	OW-08	V	SOB
Pesticides (µg/l)																									
alpha-BHC	0.003	0.006	--		0 / 5	--		--	--	0.002 J	0 / 4	--		--	--	--	0 / 4	--		--	--	0.002 J	OW-25	U	DOB
beta-BHC	0.003	0.006	0.04 J		0 / 5	--		--	--	--	0 / 4	--		--	--	--	0 / 4	--		--	--	0.04 J	OW-26	U	SOB
delta-BHC	0.003	0.006	--		0 / 5	--		--	--	--	2 / 4	0.0006 J	0.002 J	OW-07	V	--	1 / 4	0.0008 J		OW-01	D	0.002 J	OW-07	V	DOB
4,4'-DDE	0.005	0.01	0.02		3 / 5	0.0005 J	0.003 J	MW-211S	D	0.003 J	4 / 4	0.0006 J	0.004 J	MW-211D	D	--	2 / 4	0.0007 J	0.001 J	MW-212B	D	0.02 J	OW-26	U	SOB
4,4'-DDD	0.005	0.01	0.003 J		2 / 5	0.006 J	0.007	OW-03	D	--	0 / 4	--		--	--	--	0 / 4	--		--	--	0.003 J	OW-27	U	SOB
4,4'-DDT	0.005	0.01	--		0 / 5	--		--	--	--	1 / 4	0.002 J		OW-07	V	--	0 / 4	--		--	--	0.002 J	OW-07	V	DOB
Endosulfan II	0.005	0.01	--		1 / 5	0.002 J		OW-08	V	--	0 / 4	--		--	--	--	0 / 4	--		--	--	0.002 J	OW-08	V	SOB
Endosulfan Sulfate	0.005	0.01	--		1 / 5	0.002 J		OW-03	D	--	0 / 4	--		--	--	--	1 / 4	0.0008 J		MW-211B	D	0.002 J	OW-03	D	SOB
Endrin	0.005	0.01	--		0 / 5	--		--	--	--	1 / 4	0.001 J		OW-07	V	--	0 / 4	--		--	--	0.001 J	OW-07	V	DOB
PCBs (µg/l)																									
None Detected																									
Total Petroleum Hydrocarbons (mg/l)																									
None Detected																									
Metals (µg/l)																									
Iron (8)	9.7		92.5	1,320	5 / 5	3,330	82,000	MW-211S	D	83.1	4 / 4	849	63,600	MW-211D	D	--	1 / 4	1,100		MW-212B	D	82,000	MW-211S	D	SOB
Calcium	14.5		20,600	46,000	5 / 5	10,400	83,700	MW-211S	D	410,000 J	4 / 4	20,500	96,600	MW-211D	D	--	4 / 4	45,100	75,800	OW-01	D	410,000 J	OW-25	U	DOB
Magnesium	5.4		1,460	3,620	5 / 5	1,540	14,400 J	OW-08	V	49,000 J	4 / 4	2,690	16,000	MW-211D	D	194,000	4 / 4	4,010	7,980	OW-01	D	194,000	MW-207B	U	BR
Sodium	150		110,000	279,000	5 / 5	11,500 J	72,600	MW-212S	D	--	4 / 4	34,400	131,000 J	OW-07	V	27.4	4 / 4	9,660	65,800	MW-212B	D	131,000 J	OW-07	V	DOB
Potassium	30.8		4,080 J	11,200 J	5 / 5	2,820	21,100	MW-211S	D	82,300	4 / 4	3,040	22,300	MW-211D	D	44,200 J	4 / 4	1,920	5,810	MW-212B	D	82,300	OW-25	U	DOB
Barium	0.20		11.5 J	15.3 J	5 / 5	24.4	149	MW-211S	D	419	4 / 4	21.7	109	MW-211D	D	81.5	2 / 4	7.5	21.2	MW-212B	D	419	OW-25	U	DOB
Manganese	0.20		22.4	168	5 / 5	700	2,300	MW-211S	D	3,740	4 / 4	1,110	4,770	MW-211D	D	10.4	3 / 4	229	2,100	MW-212B	D	4,770	MW-211D	D	DOB
Arsenic	2.7		13.4	33.7	5 / 5	5.5	186	MW-211S	D	3.1	4 / 4	7.2	278	MW-211D	D	2.1 J	3 / 4	2.8	11.9	MW-211B	D	278	MW-211D	D	DOB
Cadmium	0.50		--		0 / 5	--		--	--	2.0	0 / 4	--		--	--	--	0 / 4	--		--	--	2.0	OW-25	U	DOB
Chromium	0.70		--		0 / 5	--		--	--	--	0 / 4	--		--	--	0.83 J	0 / 4	--		--	--	0.83 J	MW-207B	U	BR
Cobalt	0.50		1.5		2 / 5	3.0	6.1	MW-211S	D	9.8	1 / 4	10.7		MW-211D	D	0.53	0 / 4	--		--	--	10.7	MW-211D	D	DOB
Lead	1.6		2.0		0 / 5	--		--	--	--	0 / 4	--		--	--	--	0 / 4	--		--	--	2.0	OW-26	U	SOB
Nickel	2.4		2.5	3.6	0 / 5	--		--	--	3.8	0 / 4	--		--	--	--	0 / 4	--		--	--	3.8	OW-25	U	DOB
Silver	0.60		--		0 / 5	--		--	--	--	0 / 4	--		--	--	27.4	0 / 4	--		--	--	27.4	MW-207B	U	BR
Vanadium	0.60		0.72	1.7	3 / 5	1.0	3.6	MW-211S	D	1.1	1 / 4	2.7		MW-211D	D	--	0 / 4	--		--	--	2.7	MW-211D	D	DOB
Water Quality Parameters (mg/l)																									
Alkalinity (as $CaCO_3$)	1		260		1 / 1	54		MW-212S	D	126	1 / 1	51		MW-212D	D	38	1 / 1	106		MW-212B	D	260	OW-26	U	SOB
Hardness	NA		57	130	5 / 5	32	262	MW-210S	D	1,226 J	5 / 5	62	311	MW-211D	D	5,144 5,439	4 / 4	129	222	OW-01	D	5,439	MW-207B	U	BR
Chloride	0.5		291		1 / 1	111		MW-212S	D	440	1 / 1	97.0		MW-212D	D	190	1 / 1	129		MW-212B	D	440	OW-25	U	DOB
Nitrate/Nitrite as Nitrogen	0.01		--		0 / 1	--		--	--	0.02	0 / 1	--		--	--	--	1 / 1	0.01		MW-212B	D	0.02	OW-25	U	DOB
Sulfate	5		215		1 / 1	14		MW-212S	D	186	1 / 1	11		MW-212D	D	101	1 / 1	31		MW-212B	D	215	OW-26	U	SOB
Total Phosphorus	0.0050		0.35		1 / 1	0.072		MW-212S	D	0.046	1 / 1	0.057		MW-212D	D	--	1 / 1	0.033		MW-212B	D	0.35	OW-26	U	SOB
Cyanide (µg/l)	10.0		--		0 / 5	--		--	--	208 J	0 / 4	--		--	--	189	0 / 4	--		--	--	208 J	OW-25	U	DOB
Biochemical Oxygen Demand	1.0		1.1		0 / 1	--		--	--	--	0 / 1	--		--	--	--	0 / 1	--		--	--	1.1	OW-26	U	SOB
Chemical Oxygen Demand	5		60		1 / 1	9		MW-212S	D	440	1 / 1	10		MW-212D	D	190	1 / 1	12		MW-212B	D	440	OW-25	U	DOB
Total Dissolved Solids	5		1,260		1 / 1	268		MW-212S	D	186	1 / 1	288		MW-212D	D	101	1 / 1	404		MW-212B	D	1,260	OW-26	U	SOB
Total Suspended Solids	0.5		0.7		1 / 1	0.9		MW-212S	D	6.0	1 / 1	2.1		MW-212D	D	12	1 / 1	2.3		MW-212B	D	12	MW-207B	U	BR
Total Organic Carbon	0.5		22		1 / 1	2.3		MW-212S	D	1.3	1 / 1	2.0		MW-212D	D	--	1 / 1	3.0		MW-212B	D	22	OW-26	U	SOB

TABLE 4-17 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE RSI LANDFILL (JULY 1995) (1)

	Shallow Overburden									Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient Range of Values (3)		Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Min.	Max.	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
Field Parameters																									
pH	NA		6.1	6.4	5 / 5	5.5	6.8	OW-08	V	6.9	4 / 4	5.8	7.0	OW-07	V	6.3	4 / 4	6.7	7.0	MW-210B	D	7.0	OW-07	V	DOB
																							MW-210B	D	BR
Specific Conductance (µmhos/cm)	NA		1,800	3,600	5 / 5	250	500	OW-03	D	20,000	4 / 4	430	850	OW-07	V	19,000	4 / 4	390	800	OW-01	D	20,000	OW-25	U	DOB
Redox Potential (mV)	NA		-110	-47	5 / 5	-37	397	MW-211S	D	68.8	4 / 4	-19	445	MW-211D	D	209	4 / 4	-23	292	MW-211B	D	445	MW-211D	D	DOB
Dissolved Oxygen (mg/l)	NA		0.0		5 / 5	0.2	11	MW-210S	D	0.0	4 / 4	0.6	15	OW-07	V	0.4	4 / 4	0.2	11	MW-210B	D	15	OW-07	V	DOB
Turbidity (NTU)	NA		0		5 / 5	2	120	MW-210S	D	0	4 / 4	1	23	OW-07	V	0	4 / 4	4	160	MW-210B	D	160	MW-210B	D	BR
Temperature (C)	NA		25.0		5 / 5	12.0	19.8	MW-210S	D	25.0	4 / 4	11.0	13.1	MW-211D	D	16.1	4 / 4	11.1	18.9	MW-210B	D	25.0	OW-26	U	SOB
																							OW-27	U	SOB
																							OW-25	U	DOB

NOTES:

1 Analytical data is presented in Appendix F.

2 SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.

3 Upgradient Wells: shallow overburden - OW-26/27; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
deep overburden - OW-25
bedrock - MW-207B

4 Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.

5 Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
A single concentration is presented when only one positive detection has occurred.

6 "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.

7 Flow Zones: SOB - shallow overburden
DOB - deep overburden
BR - bedrock

8 Many results for this analyte were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.

--- Analyte was not detected in samples from this grouping

N- Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-18. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE B&M LOCOMOTIVE SHOP DISPOSAL AREAS (MARCH/APRIL 1995) (1)

			Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
Analyte	Range of SQLs (2) Min.	Range of SQLs (2) Max.	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Value	Location	Area	Flow Zone (7)
Volatile Organics (µg/l)																								
Toluene	10		--	0 / 3	--		--	--	9 J	0 / 3	--		--	--	--	0 / 2	--		--	--	9 J	MW 204D	U	DOB
Semivolatile Organics (µg/l)																								
None Detected																								
Pesticides (µg/l)																								
4,4'-DDT	0.005	0.006	--	0 / 3	--		--	--	--	1 / 3	0.002 J		OW-39	V	--	0 / 2	--		--	--	0.002 J	OW-39	V	DOB
Heptachlor Epoxide	0.003	0.004	0.003	0 / 3	--		--	--	--	0 / 3	--		--	--	--	1 / 2	0.001 J		MW-206B	D	0.003 J	MW-204S	U	SOB
Endosulfan I	0.003	0.004	0.003	0 / 3	--		--	--	--	0 / 3	--		--	--	--	0 / 2	--		--	--	0.003	MW-204S	U	SOB
Endosulfan II	0.005	0.006	0.004 J	0 / 3	--		--	--	--	0 / 3	--		--	--	--	0 / 2	--		--	--	0.004 J	MW-204S	U	SOB
Endosulfan Sulfate	0.005	0.006	--	0 / 3	--		--	--	--	0 / 3	--		--	--	--	1 / 2	0.001 J		MW-206B	D	0.001 J	MW-206B	D	BR
alpha-Chlordane	0.003	0.004	--	1 / 3	0.0004 J		MW-205S	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	0.0004 J	MW-205S	D	SOB
PCBs (µg/l)																								
Aroclor-1260	0.05	0.06	--	1 / 3	0.008 J		MW-206S	D	--	2 / 3	0.009 J		MW-206D	D	0.01 J	1 / 2	0.007 J		MW-205B	D	0.01 J	MW-204B MW-206D	U D	BR DOB
Total Petroleum Hydrocarbons (mg/	1.0		--	0 / 3	--		--	--	--	1 / 3	1.4		MW-206D	D	--	0 / 2	--		--	--	1.4	MW-206D	D	DOB
Metals (µg/l)																								
Aluminum (8)	25		--	0 / 3	--		--	--	841	0 / 3	--		--	--	--	0 / 2	--		--	--	841	MW-204D	U	DOB
Iron (8)	30.0		3,890	2 / 3	1,500	2,370 J	MW-205S	D	74.4 J	2 / 3	44.2 J	196 J	MW-205D	D	82.2 J	0 / 2	--		--	--	3,890	MW-204S	U	SOB
Calcium	10.0		38,900	3 / 3	13,600	152,000	MW-205S	D	38,000	3 / 3	17,400	90,500	MW-205D	D	9,600	2 / 2	8,150	47,300	MW-206B	D	152,000	MW-205S	D	SOB
Magnesium	15.0		7,780	3 / 3	1,270	30,100	MW-205S	D	137	3 / 3	4,450	21,900	MW-205D	D	1,510	2 / 2	2,600	12,500	MW-206B	D	30,100	MW-205S	D	SOB
Sodium	10.0		13,300	3 / 3	3,140	24,700	MW-206S	D	22,300	3 / 3	14,600	34,200	MW-205D	D	11,500	2 / 2	8,810	71,600	MW-206B	D	71,600	MW-206B	D	BR
Potassium	200		2,490	3 / 3	771	9,490	MW-205S	D	3,390	3 / 3	1,950	9,970	MW-205D	D	2,510	2 / 2	1,630	7,020	MW-206B	D	9,970	MW-205D	D	DOB
Barium	1.0		33.8	3 / 3	40.3	77.0	OW-40	V	5.9	3 / 3	9.3	53.7	MW-205D	D	18.8	2 / 2	1.4	25.9	MW-206B	D	77.0	OW-40	V	SOB
Manganese	1.0		5,010	2 / 3	108	1,140	MW-205S	D	--	1 / 3	829		MW-205D	D	64.0	2 / 2	137	519	MW-205B	D	5,010	MW-204S	U	SOB
Arsenic	8.0		--	0 / 3	--		--	--	11.8	0 / 3	--		--	--	--	0 / 2	--		--	--	11.8	MW-204D	U	DOB
Cobalt	2.0		16.8	2 / 3	2.5	4.6	MW-205S	D	--	2 / 3	3.2	15.4	MW-205D	D	--	0 / 2	--		--	--	16.8	MW-204S	U	SOB
Copper	3.0		--	2 / 3	7.0 J	8.7 J	MW-206S	D	--	2 / 3	10.2 J	31.1 J	MW-205D	D	--	1 / 2	5.1 J		MW-206B	D	31.1 J	MW-205D	D	DOB
Lead	3.0		--	1 / 3	3.8 J		MW-205S	D	--	1 / 3	4.7 J		MW-206D	D	2.4 J	0 / 2	--		--	--	4.7 J	MW-206D	D	DOB
Mercury	0.2		--	0 / 3	--		--	--	--	1 / 3	0.53		MW-206D	D	--	0 / 2	--		--	--	0.53	MW-206D	D	DOB
Nickel	10		--	0 / 3	--		--	--	--	1 / 3	18.3		MW-205D	D	--	0 / 2	--		--	--	18.3	MW-205D	D	DOB
Vanadium	2.0		--	0 / 3	--		--	--	23.7	0 / 3	--		--	--	--	0 / 2	--		--	--	23.7	MW-204D	U	DOB
Zinc	4.0		15.1	2 / 3	18.9	114	OW-40	V	4.8	2 / 3	4.1	11.4	MW-205D	D	--	1 / 2	6.4		MW-206B	D	114	OW-40	V	SOB
Water Quality Parameters (mg/l)																								
Alkalinity (as $CaCO_3$)	1		NA	1 / 1	446		MW-205S	D	NA	1 / 1	256		MW-205D	D	NA	1 / 1	42		MW-205B	D	446	MW-205S	D	SOB
Hardness	NA		129	3 / 3	39	503	MW-205S	D	95	3 / 3	62	316	MW-205D	D	30	2 / 2	31	170	MW-206B	D	503	MW-205S	D	SOB
Chloride	0.5		NA	1 / 1	29.8		MW-205S	D	NA	1 / 1	60.5		MW-205D	D	NA	1 / 1	5.9		MW-205B	D	60.5	MW-205D	D	DOB
Nitrate/Nitrite as Nitrogen	0.01		NA	1 / 1	0.02		MW-205S	D	NA	1 / 1	0.52		MW-205D	D	NA	0 / 1	--		--	--	0.52	MW-205D	D	DOB
Sulfate	5		NA	1 / 1	96 J		MW-205S	D	NA	1 / 1	74		MW-205D	D	NA	1 / 1	7.0		MW-205B	D	96 J	MW-205S	D	SOB
Total Phosphorus	0.005		NA	1 / 1	0.016		MW-205S	D	NA	1 / 1	0.025		MW-205D	D	NA	1 / 1	0.20		MW-205B	D	0.20	MW-205B	D	BR
Cyanide (µg/l)	--		--	0 / 3	--		--	--	--	0 / 3	--		--	--	--	0 / 2	--		--	--	--	--	--	--
Biochemical Oxygen Demand	--		--	0 / 1	--		--	--	--	0 / 1	--		--	--	--	0 / 1	--		--	--	--	--	--	--
Chemical Oxygen Demand	5		NA	1 / 1	18		MW-205S	D	NA	1 / 1	14		MW-205D	D	NA	0 / 1	--		--	--	18	MW-205S	D	SOB
Total Dissolved Solids	5		NA	1 / 1	624		MW-205S	D	NA	1 / 1	447		MW-205D	D	NA	1 / 1	57		MW-205B	D	624	MW-205S	D	SOB
Total Suspended Solids	0.5		NA	1 / 1	6.3		MW-205S	D	NA	1 / 1	0.1		MW-205D	D	NA	1 / 1	1.2		MW-205B	D	6.3	MW-205S	D	SOB
Total Organic Carbon	0.5		NA	1 / 1	8.5		MW-205S	D	NA	1 / 1	6.1		MW-205D	D	NA	0 / 1	--		--	--	8.5	MW-205S	D	SOB

TABLE 4-18 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE B&M LOCOMOTIVE SHOP DISPOSAL AREAS (MARCH/APRIL 1995) (1)

			Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
Field Parameters																								
pH	NA		5.6	3 / 3	6.5	6.9	MW-205S	D	11	3 / 3	6.2	6.6	MW-205D	D	7.6	2 / 2	6.3	7.0	MW-205B	D	11	MW-204D	U	DOB
Specific Conductance (µmhos/cm)	NA		470	3 / 3	86	850	MW-205S	D	380	3 / 3	100	680	MW-205D	D	99	2 / 2	94	950	MW-206B	D	950	MW-206B	D	BR
Redox Potential (mV)	NA		NM	3 / 3	24	182	MW-206S	D	-73	3 / 3	192	220	OW-39	V	15.3	2 / 2	125	168	MW-206B	D	220	OW-39	V	DOB
Dissolved Oxygen (mg/l)	NA		0.0	3 / 3	0.7	2.4	MW-206S	D	3.0	3 / 3	0.2	2.5	MW-206D	D	0.2	2 / 2	0.4	1.0	MW-206B	D	2.5	MW-206D	D	DOB
Turbidity (NTU)	NA		16	3 / 3	0	19	OW-40	V	9	3 / 3	0	10	OW-39	V	0	2 / 2	1	1	MW-206B	D	19	OW-40	V	SOB
Temperature (C)	NA		10.1	3 / 3	6.4	11.0	MW-205S	D	14.0	3 / 3	10.5	11.8	MW-205D	D	11.5	2 / 2	11.8	11.9	MW-205B	D	11.9	MW-205B	D	BR

NOTES:
1 Analytical data is presented in Appendix F.
2 SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3 Upgradient Wells: shallow overburden - MW-204S; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
deep overburden - MW-204D
bedrock - MW-204B
4 Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
5 Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
A single concentration is presented when only one positive detection has occurred.
6 "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.
7 Flow Zones: SOB - shallow overburden
DOB - deep overburden
BR - bedrock
8 Many results for these analytes were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.
--- Analyte was not detected in samples from this grouping
' - Not Applicable
, - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-19. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE B&M LOCOMOTIVE SHOP DISPOSAL AREAS (JULY 1995) (1)

			Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
Volatile Organics (µg/l)																								
Toluene		10	--	0 / 3	--		--	--	4 J	0 / 3	--		--	--	--	0 / 2	--		--	--	4 J	MW-204D	U	DOB
4-Methyl-2-pentanone		10	16	0 / 3	--		--	--	--	0 / 3	--		--	--	--	0 / 2	--		--	--	16	MW-204S	U	SOB
1,1,2,2-Tetrachloroethane		10	3 J	0 / 3	--		--	--	--	0 / 3	--		--	--	--	0 / 2	--		--	--	3 J	MW-204S	U	SOB
1,2-Dichloroethane		10	--	1 / 3	3 J		OW-40	V	--	0 / 3	--		--	--	--	0 / 2	--		--	--	3 J	OW-40	V	SOB
Semivolatile Organics (µg/l)																								
None Detected																								
Pesticides (µg/l)																								
delta-BHC	0.003	0.004	0.001 J	0 / 3	--		--	--	--	0 / 3	--		--	--	--	0 / 2	--		--	--	0.001 J	MW-204S	U	SOB
Endosulfan I	0.003	0.004	--	0 / 3	--		--	--	--	1 / 3	0.0006 J		OW-39	V	--	0 / 2	--		--	--	0.0006 J	OW-39	V	DOB
Endosulfan Sulfate	0.005	0.006	--	0 / 3	--		--	--	0.004 J	0 / 3	--		--	--	--	0 / 2	--		--	--	0.004 J	MW-204D	U	DOB
gamma-Chlordane	0.003	0.004	--	1 / 3	0.0004 J		MW-205S	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	0.0004 J	MW-205S	D	SOB
PCBs (µg/l)																								
None Detected																								
Total Petroleum Hydrocarbons (mg/l)																								
None Detected																								
Metals (µg/l)																								
Iron (8)		9.7	1,570	1 / 3	2,500		OW-40	V	16,600	1 / 3	98.3 J		MW-205D	D	264	2 / 2	19.9	149	MW-206B	D	2,500	OW-40	V	SOB
Calcium		14.5	38,800 J	3 / 3	12,700 J	54,900	MW-206S	D	--	3 / 3	15,300 J	36,000 J	MW-205D	D	7,530	2 / 2	7,640 J	68,000	MW-206B	D	68,000	MW-206B	D	BR
Magnesium		5.4	8,270 J	3 / 3	1,050 J	7,380	MW-206S	D	17,400	3 / 3	3,570 J	5,450	MW-206D	D	1,370	2 / 2	2,260 J	20,000	MW-206B	D	20,000	MW-206B	D	BR
Sodium		150	13,700 J	3 / 3	4,320 J	37,400	MW-206S	D	1,610 J	3 / 3	12,500 J	46,400	MW-206D	D	10,800	2 / 2	9,070 J	176,000	MW-206B	D	176,000	MW-206B	D	BR
Potassium		30.8	1,790	3 / 3	959	8,280 J	MW-206S	D	--	3 / 3	1,560	9,160 J	MW-206D	D	1,630 J	2 / 2	1,310	7,450 J	MW-206B	D	9,160 J	MW-206D	D	DOB
Barium		0.20	37.2	1 / 3	100		OW-40	V	--	1 / 3	43.0 J		MW-205D	D	14.2	1 / 2	23.7 J		MW-206B	D	100	OW-40	V	SOB
Manganese		0.20	11,000	3 / 3	10.5 J	61.8	OW-40	V	--	2 / 3	4.8	424 J	MW-205D	D	91.4	2 / 2	296	514	MW-205B	D	11,000	MW-204S	U	SOB
Arsenic		2.7	--	1 / 3	4.3 J		MW-205S	D	16.6	0 / 3	--		--	--	5.1	0 / 2	--		--	--	16.6	MW-204D	U	DOB
Chromium		0.70	--	0 / 3	--		--	--	1.0	0 / 3	--		--	--	--	0 / 2	--		--	--	1.0	MW-204D	U	DOB
Cobalt		0.50	55.3	1 / 3	3.1		MW-206S	D	--	1 / 3	0.86		MW-206D	D	--	1 / 2	1.9		MW-206B	D	55.3	MW-204S	U	SOB
Copper		0.50	--	0 / 3	--		--	--	--	0 / 3	--		--	--	--	1 / 2	4.4		MW-206B	D	4.4	MW-206B	D	BR
Lead		1.6	--	0 / 3	--		--	--	--	0 / 3	--		--	--	--	1 / 2	1.9		MW-206B	D	1.9	MW-206B	D	BR
Nickel		2.4	14.7	2 / 3	2.8	7.3	OW-40	V	--	2 / 3	3.4	4.6	MW-205D	D	--	1 / 2	4.0		MW-206B	D	14.7	MW-204S	U	SOB
Vanadium		0.60	--	0 / 3	--		--	--	24.3	0 / 3	--		--	--	--	0 / 2	--		--	--	24.3	MW-204D	U	DOB
Zinc		1.2	--	1 / 3	136		OW-40	V	--	1 / 3	261		MW-205D	D	--	0 / 2	--		--	--	261	MW-205D	D	DOB
Water Quality Parameters (mg/l)																								
Alkalinity (as $CaCO_3$)		1	NA	NA	NA		NA	NA	NA	1 / 1	70		MW-206D	D	NA	NA	NA		NA	NA	70	MW-206D	D	DOB
Hardness		NA	288	3 / 3	39	503	MW-205S	D	7	3 / 3	62	316	MW-205D	D	22	2 / 2	31	170	MW-206B	D	503	MW-205S	D	SOB
Chloride		0.5	NA	NA	NA		NA	NA	NA	1 / 1	88.4		MW-206D	D	NA	NA	NA		NA	NA	88.4	MW-206D	D	DOB
Nitrate/Nitrite as Nitrogen		0.01	NA	NA	NA		NA	NA	NA	1 / 1	3.30		MW-206D	D	NA	NA	NA		NA	NA	3.30	MW-206D	D	DOB
Sulfate		5	NA	NA	NA		NA	NA	NA	1 / 1	15		MW-206D	D	NA	NA	NA		NA	NA	15	MW-206D	D	DOB
Total Phosphorus - None Detected																								
Cyanide (µg/l) - None Detected																								
Biological Oxygen Demand - None Detected																								
Chemical Oxygen Demand		5	NA	NA	NA		NA	NA	NA	1 / 1	6		MW-206D	D	NA	NA	NA		NA	NA	6	MW-206D	D	DOB
Total Dissolved Solids		5	NA	NA	NA		NA	NA	NA	1 / 1	323		MW-206D	D	NA	NA	NA		NA	NA	323	MW-206D	D	DOB
Total Suspended Solids		0.5	NA	NA	NA		NA	NA	NA	1 / 1	0.6		MW-206D	D	NA	NA	NA		NA	NA	0.6	MW-206D	D	DOB
Total Organic Carbon		0.5	NA	NA	NA		NA	NA	NA	1 / 1	1.0		MW-206D	D	NA	NA	NA		NA	NA	1.0	MW-206D	D	DOB

TABLE 4-19 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE B&M LOCOMOTIVE SHOP DISPOSAL AREAS (JULY 1995) (1)

			Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
Field Parameters																								
pH	NA		4.7	3 / 3	4.8	6.7	MW-205S	D	9.8	3 / 3	4.9	6.6	MW-205D	D	7.1	2 / 2	6.2	7.0	MW-205B	D	7.1	MW-204B	U	BR
Specific Conductance (μmhos/cm)	NA		450	3 / 3	140	1,000	MW-205S	D	190	3 / 3	220	930	MW-205D	D	110	2 / 2	110	1,600	MW-206B	D	1,600	MW-206B	D	BR
Redox Potential (mV)	NA		278	3 / 3	50.0	255	OW-40	V	-255	3 / 3	40.0	608	OW-39	V	-94.7	2 / 2	86.0	100	MW-205B	D	608	OW-39	V	DOB
Dissolved Oxygen (mg/l)	NA		0.8	3 / 3	1.5	14	MW-205S	D	9.8	3 / 3	1.2	14	MW-205D	D	0.3	2 / 2	4.0	13	MW-205B	D	14	MW-205S	D	SOB
																						MW-205D	D	DOB
Turbidity (NTU)	NA		0	3 / 3	2	94	MW-205S	D	0	3 / 3	2	95	MW-205D	D	0	2 / 2	0	100	MW-205B	D	100	MW-205B	D	BR
Temperature (C)	NA		13.9	3 / 3	13.1	17.5	OW-40	V	16.9	3 / 3	12.7	14.0	MW-206D	D	15.7	2 / 2	17.0	17.3	MW-205B	D	17.5	OW-40	V	SOB

NOTES:
1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Upgradient Wells: shallow overburden - MW-204S; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
   deep overburden - MW-204D
   bedrock - MW-204B
4. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
   Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
5. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
   A single concentration is presented when only one positive detection has occurred.
6. "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.
7. Flow Zones: SOB - shallow overburden
   DOB - deep overburden
   BR - bedrock
8. Many results for this analyte were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.

-- - Analyte was not detected in samples from this grouping
NA - Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-20. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE OLD B&M OIL/SLUDGE RECYCLING AREA (MARCH/APRIL 1995) (1)

			Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
Volatile Organics (µg/l)																								
Chlorobenzene	10		--	1 / 5	3 J		MW-202S	D	--	0 / 5	--		--	--	--	0 / 4	--		--	--	3 J	MW-202S	D	SOB
1,1,1-Trichloroethane	10		7 J	0 / 5	--		--	--	--	1 / 5	4 J		MW-203D	D	--	0 / 4	--		--	--	7 J	MW-201S	U	SOB
1,1-Dichloroethane	10		--	0 / 5	--		--	--	--	1 / 5	3 J		MW-203D	D	--	1 / 4	4 J		OW-37	D	4 J	OW-37	D	BR
Chloroform	10		--	0 / 5	--		--	--	--	0 / 5	--		--	--	--	1 / 4	3 J		MW-203B	D	3 J	MW-203B	D	BR
Carbon Disulfide	10		--	0 / 5	--		--	--	--	0 / 5	--		--	--	5 J	0 / 4	--		--	--	5 J	MW-201B	U	BR
Semivolatile Organics (µg/l)																								
None Detected																								
Pesticides (µg/l)																								
4,4'-DDD	0.005	0.01	--	2 / 5	0.0007 J	0.0008 J	MW-202S	D	--	1 / 5	0.0006 J		OW-18	V	--	1 / 4	0.0004 J		OW-37	D	0.0008 J	MW-201S	D	SOB
Heptachlor Epoxide	0.003	0.006	--	0 / 5	--		--	--	--	1 / 5	0.0006 J		OW-18	V	0.002 J	0 / 4	--		--	--	0.002 J	MW-201B	U	BR
Endosulfan Sulfate	0.005	0.01	--	0 / 5	--		--	--	--	1 / 5	0.0007 J		MW-203D	D	--	0 / 4	--		--	--	0.0007 J	MW-203D	D	DOB
Dieldrin	0.005	0.01	--	1 / 5	0.0004 J		OW-19	V	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.0004 J	OW-19	V	SOB
Endrin Aldehyde	0.008	0.02	--	0 / 5	--		--	--	--	1 / 5	0.0009 J		MW-202D	D	--	0 / 4	--		--	--	0.0009 J	MW-202D	D	DOB
PCBs (µg/l)																								
Aroclor-1260	0.05	0.06	--	3 / 5	0.01 J	0.02 J	MW-202S	D	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.02 J	MW-202S	D	SOB
																						OW-19	V	SOB
Total Petroleum Hydrocarbons (mg/l)	1.0		--	0 / 5	--		--	--	--	1 / 5	2.5		MW-202D	D	--	0 / 4	--		--	--	2.5	MW-202D	D	DOB
Metals (µg/l)																								
Iron (8)	30.0		--	5 / 5	1,950	23,500	OW-43	S	53.2	1 / 5	124		OW-18	V	63.9	3 / 4	158	1,190	OW-37	D	23,500	OW-43	S	SOB
Calcium	10.0		17,700	5 / 5	8,820	13,100	OW-43	S	13,500	5 / 5	13,000	28,400	OW-38	V	13,700	4 / 4	12,000	119,000	OW-37	D	119,000	OW-37	D	BR
Magnesium	15.0		2,510	5 / 5	1,480	4,550	MW-202S	D	1,280	5 / 5	2,880	5,340	MW-203D	D	2,360	4 / 4	1,980	23,000	OW-37	D	23,000	OW-37	D	BR
Sodium	10.0		9,020	5 / 5	2,440	15,900	MW-202S	D	17,600	5 / 5	4,480	28,900	MW-202D	D	13,100	4 / 4	10,000	115,000	OW-37	D	115,000	OW-37	D	BR
Potassium	200		2,270	5 / 5	1,090	3,120	MW-202S	D	1,450	5 / 5	1,690	3,700	MW-202D	D	1,940	4 / 4	1,210	15,000	OW-37	D	15,000	OW-37	D	BR
Barium	1.0		23.6	3 / 5	9.8	33.3	OW-42	S	--	4 / 5	18.1	31.7	MW-202D	D	11.8	3 / 4	17.6	117	OW-37	D	117	OW-37	D	BR
Manganese	1.0		249	5 / 5	72.5	1,480	OW-42	S	10.2	5 / 5	262	1,370	OW-38	V	48.0	4 / 4	21.3	1,340	OW-37	D	1,480	OW-42	S	SOB
Cobalt	2.0		--	1 / 5	14.7		OW-42	S	--	0 / 5	--		--	--	--	1 / 4	4.6		OW-37	D	14.7	OW-42	S	SOB
Copper	3.0		--	0 / 5	--		--	--	--	0 / 5	--		--	--	--	1 / 4	42.2 J		OW-37	D	42.2 J	OW-37	D	BR
Lead	3.0		--	1 / 5	3.3 J		OW-43	S	--	0 / 5	--		--	--	--	1 / 4	7.3 J		OW-37	D	7.3 J	OW-37	D	BR
Mercury	0.20		--	1 / 5	0.37		MW-203S	D	--	2 / 5	0.22		MW-203D	D	--	0 / 4	--		--	--	0.37	MW-203S	D	SOB
													OW-41	D										
Vanadium	2.0		--	0 / 5	--		--	--	--	0 / 5	--		--	--	2.1	0 / 4	--		--	--				
Zinc	4.0		104	0 / 5	--		--	--	--	0 / 5	--		--	--	--	1 / 4	30.4		OW-37	D	104	MW 201S	U	SOB
Water Quality Parameters (mg/l)																								
Alkalinity (as $CaCO_3$)	1		NA	1 / 1	50		MW-203S	D	NA	2 / 2	74	82	OW-38	V	NA	2 / 2	44	63	OW-37	D	82	OW-38	V	DOB
Hardness	NA		55	5 / 5	29	50	MW-202S	D	39	5 / 5	44	93	OW-38	V	44	4 / 4	38	392	OW-37	D	392	OW-37	D	BR
Chloride	0.5		NA	1 / 1	4.0		MW-203S	D	NA	2 / 2	21.6	42.5	OW-38	V	NA	2 / 2	12.0	560	OW-37	D	560	OW-37	D	BR
Nitrate/Nitrite as Nitrogen	0.01		NA	0 / 1	--		--	--	NA	2 / 2	0.01	0.05	MW-203D	D	NA	1 / 2	0.01		MW-203B	D	0.05	MW-203D	D	DOB
Sulfate	5		NA	1 / 1	14		MW-203S	D	NA	2 / 2	15	27	MW-203D	D	NA	2 / 2	32	44	MW-203B	D	44	MW-203B	D	BR
Total Phosphorus	0.005		NA	1 / 1	0.056		MW-203S	D	NA	2 / 2	0.015	0.022	MW-203D	D	NA	2 / 2	0.01	0.024	MW-203B	D	0.056	MW-203S	D	SOB
Cyanide (µg/l)	--		-	0 / 1	--		--	--	--	0 / 1	--	--	--	--	--	0 / 3	--		--	--	--	--	--	--
Biochemical Oxygen Demand	1		NA	0 / 1	--		--	--	NA	0 / 2	--	--	--	--	NA	0 / 1	--		--	--	--	--	--	--
Chemical Oxygen Demand	5		NA	1 / 1	17		MW-203S	D	NA	0 / 2	--	--	--	--	NA	1 / 2	29		OW-37	D	29	OW-37	D	BR
Total Dissolved Solids	5		NA	1 / 1	64		MW-203S	D	NA	2 / 2	139	172	OW-38	V	NA	2 / 2	108	1,060	OW-37	D	1,060	OW-37	D	BR
Total Suspended Solids	0.5		NA	0 / 1	--		--	--	NA	0 / 2	--	--	--	--	NA	2 / 2	1.4	1.7	OW-37	D	1.7	OW-37	D	BR
Total Organic Carbon	0.5		NA	1 / 1	4.6		MW-203S	D	NA	2 / 2	1.0	3.0	OW-38	V	NA	2 / 2	0.7	1.2	OW-37	D	4.6	MW-203S	D	SOB

TABLE 4-20 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE OLD B&M OIL/SLUDGE RECYCLING AREA (MARCH/APRIL 1995) (1)

Analyte	Range of SQLs (2)		Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Min.	Max.	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Value	Location	Area	Flow Zone (7)
Field Parameters																								
pH			6.3	5 / 5	5.7	6.4	MW-202S	D	8.8	5 / 5	6.0	6.4	OW-38	V	9.2	4 / 4	6.6	8.1	MW-202B	D	9.2	MW-201B	U	BR
Specific Conductance (µmhos/cm)	NA		150	5 / 5	81	170	MW-202S	D	150	5 / 5	87	280	MW-202D	D	140	4 / 4	150	2,000	OW-37	D	2,000	OW-37	D	BR
Redox Potential (mV)	NA		154	5 / 5	-38	77	0W-43	S	-30	4 / 5	3.7	262	MW-202D	D	88	4 / 4	5.4	253	MW-203B	D	262	MW-202D	D	DOB
Dissolved Oxygen (mg/l)	NA		0.7	5 / 5	0.2	0.7	MW-203S	D	0.7	5 / 5	0.0	1.2	MW-202D	D	1.3	4 / 4	0.3	2.3	OW-37	D	2.3	OW-37	D	BR
Turbidity (NTU)	NA		1	5 / 5	0	2	MW-203S	D	2	5 / 5	0	2	MW-202D	D	3	4 / 4	0	20	MW-202B	D	20	MW-202B	D	BR
Temperature (C)	NA		5.0	5 / 5	5.7	9.7	OW-42	S	8.1	5 / 5	9.7	12.1	OW-18	V	9.2	4 / 4	10.0	10.6	OW-37	D	12.1	OW-18	V	DOB

NOTES:

1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Upgradient Wells: shallow overburden - MW-201S; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
   deep overburden - MW-201D
   bedrock - MW-201B
4. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
   Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
5. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
   A single concentration is presented when only one positive detection has occurred.
6. "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.
7. Flow Zones: SOB - shallow overburden
   DOB - deep overburden
   BR - bedrock
8. Many results for this analyte were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.

-- - Analyte was not detected in samples from this grouping
NA - Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-21. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE OLD B&M OIL/SLUDGE RECYCLING AREA (JULY 1995) (1)

			Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
Volatile Organics (µg/l)																								
1,1,1-Trichloroethane	10		12	0 / 5	--		--	--	--	1 / 5	6 J		MW-203D	D	--	0 / 4	--		--	--	12	MW-201S	U	SOB
1,1-Dichloroethane	10		--	0 / 5	--		--	--	--	1 / 5	3 J		MW-203D	D	--	1 / 4	3 J		OW-37	D	3 J	MW-203D	D	DOB
																						OW-37	D	BR
Semivolatile Organics (µg/l)																								
Bis(2-ethylhexyl)phthalate	10		--	2 / 5	3 J	5 J	OW-19	V	--	0 / 5	--		--	--	--	0 / 4	--		--	--	5 J	OW-19	V	SOB
Pesticides (µg/l)																								
alpha-BHC	0.003	0.004	--	1 / 5	0.002 J		OW-43	S	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.002 J	OW-43	S	SOB
delta-BHC	0.003	0.004	--	1 / 5	0.002 J		MW-203S	D	--	1 / 5	0.002 J		OW-38	D	--	0 / 4	--		--	--	0.002 J	MW-203S	D	SOB
																						OW-38	D	DOB
4,4'-DDE	0.005	0.006	--	2 / 5	0.003 J	0.005	MW-203S	D	--	2 / 5	0.0003 J	0.003 J	MW-203D	D	--	0 / 4	--		--	--	0.005	MW-203S	D	SOB
4,4'-DDT	0.005	0.006	0.001 J	0 / 5	--		--	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.001 J	MW-201S	U	SOB
Endosulfan Sulfate	0.005	0.006	0.001 J	0 / 5	--		--	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.001 J	MW-201S	U	SOB
Endrin	0.005	0.006	--	0 / 5	--		--	--	--	1 / 5	0.0008 J		MW-203D	D	--	0 / 4	--		--	--	0.0008 J	MW-203D	D	DOB
gamma-Chlordane	0.003	0.004	--	1 / 5	0.001 J		MW-203S	D	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.001 J	MW-203S	D	SOB
PCBs (µg/l)																								
None Detected																								
Total Petroleum Hydrocarbons (mg/l)																								
None Detected																								
Metals (µg/l)																								
Aluminum (8)	11.5		--	0 / 5	--		--	--	--	0 / 5	--		--	--	--	1 / 4	649		MW-202B	D	649	MW-202B	D	BR
Iron (8)	9.7		17,700 J	5 / 5	10.2 J	11,000 J	MW-203S	D	22.0 J	3 / 5	15.1 J	259	OW-38	V	6,050 J	4 / 4	133 J	4,770	OW-37	D	17,700 J	MW-201S	U	SOB
Calcium	14.5		58,600 J	5 / 5	7,840 J	37,200 J	OW-43	S	12,200 J	5 / 5	11,400 J	26,000 J	MW-203D	D	13,200 J	4 / 4	11,000	120,000	OW-37	D	120,000	OW-37	D	BR
Magnesium	5.4		9,640 J	5 / 5	1,520 J	5,530 J	OW-43	S	1,070 J	5 / 5	2,330 J	7,170 J	OW-41	S	1,860 J	4 / 4	1,760	23,100	OW-37	D	23,100	OW-37	D	BR
Sodium	150		23,000 J	5 / 5	6,480 J	15,000 J	MW-203S	D	23,900 J	5 / 5	5,890 J	30,700	MW-202D	D	3,590 J	4 / 4	10,900 J	134,000	OW-37	D	134,000	OW-37	D	BR
Potassium	30.8		5,560	5 / 5	1,120	3,660	OW-43	S	1,430	5 / 5	1,420	3,200	MW-202D	D	2,010	4 / 4	1,260	16,700 J	OW-37	D	16,700 J	OW-37	D	BR
Barium	0.20		39.1 J	3 / 5	12.6	45.6 J	OW-43	S	--	3 / 5	13.2 J	29.9	MW-202D	D	27.7 J	3 / 4	16.4 J	122	OW-37	D	122	OW-37	D	BR
Manganese	0.20		760 J	5 / 5	56.4	724 J	OW-19	V	10.8 J	5 / 5	58.5 J	1,110	OW-38	V	1,170 J	4 / 4	29.6 J	1,370	OW-37	D	1,370	OW-37	D	BR
Arsenic	2.7		13.1 J	3 / 5	9.9 J	27.1 J	OW-19	V	4.7 J	0 / 5	--		--	--	7.4 J	3 / 4	3.0	9.6 J	MW-203B	D	13.1 J	MW-201S	U	SOB
Cadmium	0.50		0.55 J	0 / 5	--		--	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	0.55 J	MW-201S	U	SOB
Chromium	0.70		--	0 / 5	--		--	--	--	1 / 5	4.7		OW-41	S	--	0 / 4	--		--	--	4.7	OW-41	S	DOB
Cobalt	0.50		4.7 J	2 / 5	3.9	4.3	MW-203S	D	--	0 / 5	--		--	--	8.1	1 / 4	5.6		OW-37	D	8.1	MW-201B	U	BR
Copper	0.50		15.3 J	0 / 5	--		--	--	--	0 / 5	--		--	--	--	1 / 4	60.9		MW-203B	D	60.9	MW-203B	D	BR
Lead	1.6		2.3 J	0 / 5	--		--	--	--	0 / 5	--		--	--	--	1 / 4	2.8		MW-203B	D	2.8	MW-203B	D	BR
Nickel	2.4		5.4 J	1 / 5	5.0		OW-43	S	--	1 / 5	3.9		MW-202D	D	--	3 / 4	2.5	112	OW-17	V	112	OW-17	V	BR
Vanadium	0.60		--	1 / 5	1.5		MW-202S	D	--	1 / 5	0.59 J		MW-202D	D	--	1 / 4	1.1		MW-202B	D	1.5	MW-202S	D	SOB
Zinc	1.2		--	1 / 5	288		OW-43	S	--	0 / 5	--		--	--	--	1 / 4	44.9		MW-202B	D	288	OW-43	S	SOB
Water Quality Parameters (mg/l)																								
Alkalinity (as $CaCO_3$)	1		NA	NA	NA		NA	NA	NA	1 / 1	24		MW-202D	D	NA	1 / 1	66		MW-202B	D	66	MW-202B	D	BR
Hardness	NA		66 J 306 J	5 / 5	26 J	116 J	OW-43	S	35 J	6 / 6	21 J	85 J	MW-203D	D	41 J	4 / 4	35	345	OW-37	D	395	OW-37	D	BR
Chloride	0.5		NA	NA	NA		NA	NA	NA	1 / 1	67.8		MW-202D	D	NA	1 / 1	3.4		MW-202B	D	67.8	MW-202D	D	DOB
Nitrate/Nitrite as Nitrogen	0.01		NA	NA	NA		NA	NA	NA	1 / 1	0.39		MW-202D	D	NA	0 / 1	--		--	--	0.39	MW-202D	D	DOB
Sulfate	5		NA	NA	NA		NA	NA	NA	1 / 1	36		MW-202D	D	NA	1 / 1	10		MW-202B	D	36	MW-202D	D	DOB
Total Phosphorus	0.0050		NA	NA	NA		NA	NA	NA	1 / 1	0.022		MW-202D	D	NA	1 / 1	1.4		MW-202B	D	1.4	MW-202B	D	BR
Cyanide (µg/l)	--		--	0 / 5	--		--	--	--	0 / 5	--		--	--	--	0 / 4	--		--	--	--	--	--	--
Biochemical Oxygen Demand	1		NA	NA	NA		NA	NA	NA	0 / 1	--		--	--	NA	0 / 1	--		--	--	--	--	--	--
Chemical Oxygen Demand	5		NA	NA	NA		NA	NA	NA	0 / 1	--		--	--	NA	0 / 1	--		--	--	--	--	--	--
Total Dissolved Solids	5		NA	NA	NA		NA	NA	NA	1 / 1	228		MW-202D	D	NA	1 / 1	114		MW-202B	D	228	MW-202D	D	DOB
Total Suspended Solids	0.5		NA	NA	NA		NA	NA	NA	1 / 1	0.7		MW-202D	D	NA	1 / 1	17		MW-202B	D	17	MW-202B	D	BR
Total Organic Carbon	0.5		NA	NA	NA		NA	NA	NA	1 / 1	0.8		MW-202D	D	NA	0 / 1	--		--	--	0.8	MW-202D	D	DOB

TABLE 4-21 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE OLD B&M OIL/SLUDGE RECYCLING AREA (JULY 1995) (1)

			Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
Field Parameters																								
pH	NA		6.3	5 / 5	4.0	6.3	OW-43	S	8.2	5 / 5	4.8	6.1	OW-38	V	8.0	4 / 4	5.6	7.8	MW-202B	D	8.2	MW-201D	U	DOB
Specific Conductance (µmhos/cm)	NA		300	5 / 5	86	360	OW-43	S	190	5 / 5	76	280	MW-202D	D	130	4 / 4	130	1,700	OW-37	D	1,700	OW-37	D	BR
Redox Potential (mV)	NA		179	5 / 5	-220	151	OW-42	S	-7.4	5 / 5	-56	127	OW-41	S	124	4 / 4	-29	24.5	OW-37	D	179	MW-201S	U	SOB
Dissolved Oxygen (mg/l)	NA		2.5	5 / 5	0.1	13	MW-202S	D	5.6	5 / 5	0.7	15	OW-38	D	1.3	4 / 4	0.6	15	OW-37	D	15	OW-38	V	DOB
																						OW-37	D	BR
Turbidity (NTU)	NA		0	5 / 5	0	110	MW-202S	D	8	5 / 5	0	18	OW-41	S	0	4 / 4	0	14	MW-202B	D	110	MW-202S	D	SOB
Temperature (C)	NA		13.6	5 / 5	12.2	17.6	OW-43	S	16.3	5 / 5	12.1	13.9	OW-38	D	12.9	4 / 4	13.0	15.5	OW-37	D	17.6	OW-43	S	SOB

NOTES:
1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Upgradient Wells: shallow overburden - MW-201S; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
   deep overburden - MW-201D
   bedrock - MW-201B
4. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
   Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
5. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
   A single concentration is presented when only one positive detection has occurred.
6. "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.
7. Flow Zones: SOB - shallow overburden
   DOB - deep overburden
   BR - bedrock
8. Many results for these analytes were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.

-- - Analyte was not detected in samples from this grouping
NA - Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-22. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE ASBESTOS LAGOON (MARCH/APRIL 1995) (1)

Analyte	Range of SQLs (2) Min.	Range of SQLs (2) Max.	Shallow Overburden Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Deep Overburden Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Bedrock Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Overall Maximum Value	Location	Area	Flow Zone (7)
Volatile Organics (µg/l)																								
1,1-Dichloroethane	10		--	1 / 4	2 J		OW-11	D	2 J	2 / 3	4 J	10	OW-20	D	--	1 / 2	9 J		OW-09	D	10	OW-20	D	DOB
1,2-Dichloroethane	10		--	0 / 4	--		--	--	--	1 / 3	3 J		OW-20	D	4 J	2 / 2	4 J	38	MW-209B	D	38	MW-209B	D	BR
Semivolatile Organics (µg/l)																								
2-Methylnaphthalene	10		--	1 / 4	3 J		OW-12	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	3 J	OW-12	D	SOB
Bis(2-ethylhexyl)phthalate	10		--	1 / 4	3 J		OW-11	D	13	1 / 3	3 J		OW-10	D	17 J	0 / 2	--		--	--	17 J	MW-208B	U	BR
Pesticides (µg/l)																								
delta-BHC	0.003	0.004	--	0 / 4	--		--	--	--	1 / 3	0.002 J		OW-20	D	--	0 / 2	--		--	--	0.002 J	OW-20	D	DOB
4,4'-DDD	0.005	0.006	--	0 / 4	--		--	--	--	1 / 3	0.0009 J		OW-13	V	--	0 / 2	--		--	--	0.0009 J	OW-13	V	DOB
Heptachlor Epoxide	0.003	0.004	--	1 / 4	0.0005 J		OW-11	D	0.002 J	2 / 3	0.004 J	0.005	OW-20	D	--	1 / 2	0.005 J		OW-09	D	0.005	OW-20	D	DOB
																						OW-09	D	BR
Endosulfan I	0.003	0.004	--	0 / 3	--		--	--	--	1 / 3	0.0008 J		OW-10	D	--	0 / 2	--		--	--	0.0008 J	OW-10	D	DOB
Endosulfan II	0.005	0.006	--	0 / 4	--		--	--	--	0 / 3	--		--	--	--	1 / 2	0.003 J		OW-09	D	0.003 J	OW-09	D	BR
Endosulfan Sulfate	0.005	0.006	--	0 / 4	--		--	--	--	2 / 3	0.0004 J	0.003 J	OW-20	D	--	1 / 2	0.0005 J		OW-09	D	0.003 J	OW-20	D	DOB
Aldrin	0.003	0.004	--	0 / 4	--		--	--	--	2 / 3	0.0004 J	0.002 J	OW-20	D	--	0 / 2	--		--	--	0.002 J	OW-20	D	DOB
Dieldrin	0.004	0.006	0.0003 J	0 / 4	--		--	--	0.0008 J	0 / 3	--		--	--	--	0 / 2	--		--	--	0.0008 J	MW-208D	U	DOB
Endrin Ketone	0.006	0.008	--	0 / 4	--		--	--	--	1 / 3	0.0006 J		OW-20	D	--	0 / 2	--		--	--	0.0006 J	OW-20	D	DOB
alpha-Chlordane	0.003	0.004	--	0 / 4	--		--	--	--	0 / 3	--		--	--	--	1 / 2	0.001 J		OW-09	D	0.001 J	OW-09	D	BR
gamma-Chlordane	0.003	0.004	--	0 / 4	--		--	--	--	1 / 3	0.0007 J		OW-20	D	--	1 / 2	0.0004 J		OW-09	D	0.0004 J	OW-09	D	BR
PCBs (µg/l)																								
Aroclor-1221	0.10	0.12	--	0 / 4	--		--	--	--	0 / 3	--		--	--	--	1 / 2	0.10 J		OW-09	D	0.10 J	OW-09	D	BR
Aroclor-1254	0.05	0.06	--	0 / 4	--		--	--	0.008 J	0 / 3	--		--	--	--	0 / 2	--		--	--	0.008 J	MW-208D	U	DOB
Total Petroleum Hydrocarbons (mg/l)																								
None Detected																								
Metals (µg/l)																								
Aluminum (8)	25		--	1 / 4	1500		OW-12	D	--	1 / 3	2460		OW-10	D	--	1 / 2	1,600		OW-09	D	2,460	OW-10	D	DOB
Iron (8)	30		17,600	4 / 4	63.2	6,210	OW-11	D	79.1	2 / 3	1,590	5,930 J	OW-20	D	753	2 / 2	390 J	532	OW-09	D	17,600	MW-208S	U	SOB
Calcium	10.0		7,600	4 / 4	3,160	43,200	OW-12	D	25,200	3 / 3	19,400	54,200	OW-20	D	53,100	2 / 2	59,300	105,000	OW-09	D	105,000	OW-09	D	BR
Magnesium	15.0		1,410	3 / 4	790	2,450	OW-11	D	5,060	3 / 3	5,010	11,400	OW-20	D	10,800	2 / 2	20,900	23,500	MW-209B	D	23,500	MW-209B	D	BR
Sodium	10.0		12,600	4 / 4	1,370	31,100	OW-12	D	34,500	3 / 3	28,500	293,000	OW-20	D	20,900	2 / 2	24,500	137,000	OW-09	D	293,000	OW-20	D	DOB
Potassium	200		2,270	4 / 4	389	8,380	OW-12	D	2,620	3 / 3	3,140	18,500	OW-20	D	5,630	2 / 2	6,890	10,600	OW-09	D	18,500	OW-20	D	DOB
Barium	1.0		36.7	4 / 4	6.4	44.7	OW-21	D	61.2	3 / 3	54.0	158	OW-20	D	40.5	2 / 2	39.1	43.4	MW-209B	D	158	OW-20	D	DOB
Manganese	1.0		1,010	4 / 4	5.6	839	OW-11	D	1,620	3 / 3	897	3,930	OW-20	D	504	2 / 2	1,140	7,280	OW-09	D	7,280	OW-09	D	BR
Beryllium	1		--	0 / 4	--		--	--	--	1 / 3	2.4		OW-10	D	--	1 / 2	2.1		OW-09	D	2.4	OW-10	D	DOB
Arsenic	8		58.1	2 / 4	13.6	16.1 J	OW-12	D	--	1 / 3	12.0		OW-20	D	--	0 / 2	--		--	--	58.1	MW-208S	U	SOB
Chromium	5		--	2 / 4	6.8	8.2 J	OW-12	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	8.2 J	OW-12	D	SOB
Cobalt	2.0		3.5	1 / 4	2.4		OW-11	D	--	3 / 3	4.1	45.4	OW-10	D	--	1 / 2	104		OW-09	D	104	OW-09	D	BR
Copper	3		--	1 / 4	22.4 J		OW-12	D	--	1 / 3	7.0 J		OW-10	D	--	1 / 2	14.6 J		OW-09	D	22.4	OW-12	D	SOB
Lead	3		--	1 / 4	63.6		OW-12	D	--	0 / 3	--		--	--	--	1 / 2	21.0 J		OW-09	D	63.6	OW-12	D	SOB
Nickel	10		--	0 / 4	--		--	--	--	2 / 3	14.2	43.8	OW-10	D	--	1 / 2	99.1		OW-09	D	99.1	OW-09	D	BR
Zinc	4		--	2 / 4	39.5 J	141	OW-21	D	--	2 / 3	6.0	106	OW-10	D	--	1 / 2	147		OW-09	D	147	OW-09	D	BR
Water Quality Parameters (mg/l)																								
Alkalinity (as $CaCO_3$)	1		NA	0 / 1	--		--	--	NA	1 / 1	108		OW-20	D	NA	1 / 1	35		MW-209B	D	108	OW-20	D	DOB
Hardness	NA		25	4 / 4	8	114	OW-12	D	84	3 / 3	69	182	OW-20	D	177	2 / 2	245	347	OW-09	D	347	OW-09	D	BR
Chloride	0.5		NA	1 / 1	5.5		OW-21	D	NA	1 / 1	746		OW-20	D	NA	1 / 1	119		MW-209B	D	746	OW-20	D	DOB
Nitrate/Nitrite as Nitrogen	0.01		NA	1 / 1	0.45		OW-21	D	NA	0 / 1	--		--	--	NA	0 / 1	--		--	--	0.45	OW-21	D	SOB
Sulfate	5		NA	1 / 1	19		OW-21	D	NA	1 / 1	31		OW-20	D	NA	1 / 1	122		MW-209B	D	122	MW-209B	D	BR
Total Phosphorus	0.005		NA	1 / 1	0.45		OW-21	D	NA	1 / 1	0.047		OW-20	D	NA	1 / 1	0.023		MW-209B	D	0.45	OW-21	D	SOB
Cyanide (µg/l)	--		--	0 / 4	--		--	--	--	0 / 3	--		--	--	--	0 / 2	--		--	--	--	--	--	--
Biochemical Oxygen Demand	--		--	0 / 1	--		--	--	--	0 / 1	--		--	--	--	0 / 1	--		--	--	--	--	--	--
Chemical Oxygen Demand	5		NA	0 / 1	--		--	--	NA	1 / 1	22 J		OW-20	D	NA	0 / 1	--		--	--	22 J	OW-20	D	DOB
Total Dissolved Solids	5		NA	1 / 1	39		OW-21	D	NA	1 / 1	1,200		OW-20	D	NA	1 / 1	401		MW-209B	D	1,200	OW-20	D	DOB
Total Suspended Solids	0.5		NA	1 / 1	0.5		OW-21	D	NA	1 / 1	6.2		OW-20	D	NA	1 / 1	0.7		MW-209B	D	6.2	OW-20	D	DOB
Total Organic Carbon	0.5		NA	1 / 1	0.6		OW-21	D	NA	1 / 1	6.2		OW-20	D	NA	1 / 1	1.0		MW-209B	D	6.2	OW-20	D	DOB

TABLE 4-22 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE ASBESTOS LAGOON (MARCH/APRIL 1995) (1)

Analyte	Range of SQLs (2) Min.	Range of SQLs (2) Max.	Shallow Overburden Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Deep Overburden Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)
Field Parameters														
pH	NA		6.0	4 / 4	5.6	8.3	OW-12	D	6.1	3 / 3	4.3	6.6	OW-20	D
Specific Conductance (µmhos/cm)	NA		170	4 / 4	27	310	OW-12	D	320	3 / 3	270	2,300	OW-20	D
Redox Potential (mV)	NA		88	4 / 4	-209	210	OW-21	D	111	3 / 3	-34	140	OW-10	D
Dissolved Oxygen (mg/l)	NA		1.1	4 / 4	1.3	6.6	OW-14	V	1.5	3 / 3	0.1	3.4	OW-13	V
Turbidity (NTU)	NA		4	4 / 4	0	1	OW-12	D	0	3 / 3	0	2	OW-10	D
Temperature (C)	NA		9.2	4 / 4	6.9	11.5	OW-14	V	11.4	3 / 3	10.6	12.2	OW-13	V

Analyte	Bedrock Upgradient Value (3)	Frequency of Detection (4)	Range of Values (5) Min.	Range of Values (5) Max.	Maximum Location	Maximum Area (6)	Overall Maximum Value	Location	Area	Flow Zone (7)
Field Parameters										
pH	7.1	2 / 2	5.2	6.9	MW-209B	D	8.3	OW-12	D	SOB
Specific Conductance (µmhos/cm)	390	2 / 2	710	2,000	OW-09	D	2,300	OW-20	D	DOB
Redox Potential (mV)	-70	2 / 2	100	125	OW-09	D	210	OW-21	D	SOB
Dissolved Oxygen (mg/l)	2.6	2 / 2	0.1	0.2	MW-209B	D	6.6	OW-14	V	SOB
Turbidity (NTU)	1	2 / 2	0	3	OW-09	D	4	MW-208S	U	SOB
Temperature (C)	8.7	2 / 2	10.4	11.8	OW-09	D	12.2	OW-13	V	DOB

NOTES:
1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Upgradient Wells: shallow overburden - MW-208S; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
   deep overburden - MW-208D
   bedrock - MW-208B
4. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
   Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
5. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
   A single concentration is presented when only one positive detection has occurred.
6. "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.
7. Flow Zones: SOB - shallow overburden
   DOB - deep overburden
   BR - bedrock
8. Many results for these analytes were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.

-- - Analyte was not detected in samples from this grouping

NA - Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-23. SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE ASBESTOS LAGOON (JULY 1995) (1)

Analyte	Range of SQLs (2) Min.	Range of SQLs (2) Max.	Shallow Overburden Upgradient Value (3)	Shallow Overburden Frequency of Detection (4)	Shallow Overburden Range of Values (5) Min.	Shallow Overburden Range of Values (5) Max.	Shallow Overburden Maximum Location	Shallow Overburden Maximum Area (6)	Deep Overburden Upgradient Value (3)	Deep Overburden Frequency of Detection (4)	Deep Overburden Range of Values (5) Min.	Deep Overburden Range of Values (5) Max.	Deep Overburden Maximum Location	Deep Overburden Maximum Area (6)	Bedrock Upgradient Value (3)	Bedrock Frequency of Detection (4)	Bedrock Range of Values (5) Min.	Bedrock Range of Values (5) Max.	Bedrock Maximum Location	Bedrock Maximum Area (6)	Overall Maximum Value	Overall Maximum Location	Overall Maximum Area	Flow Zone (7)
Volatile Organics (µg/l)																								
4-Methyl-2-pentanone	10		--	1 / 4	11		OW-12	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	11	OW-12	D	SOB
1,1,2,2-Tetrachloroethane	10		--	1 / 4	3 J		OW-12	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	3 J	OW-12	D	SOB
1,1-Dichloroethane	10		--	1 / 4	3 J		OW-11	D	--	2 / 3	4 J	7 J	OW-20	D	--	1 / 2	10 J		OW-09	D	10 J	OW-09	D	BR
1,2-Dichloroethane	10		--	0 / 4	--		--	--	--	1 / 3	3 J		OW-20	D	3 J	2 / 2	5 J	39	MW-209B	D	39	MW-209B	D	BR
Semivolatile Organics (µg/l)																								
Naphthalene	10		--	1 / 4	3 J		OW-12	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	3 J	OW-12	D	SOB
2-Methylnaphthalene	10		--	1 / 4	4 J		OW-12	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	4 J	OW-12	D	SOB
1,2-Dichlorobenzene	10		--	0 / 4	--		--	--	--	0 / 3	--		--	--	--	1 / 2	2 J		OW-09	D	2 J	OW-09	D	BR
Pesticides (µg/l)																								
delta-BHC	0.003	0.004	--	0 / 4	--		--	--	0.001 J	1 / 3	0.004 J		OW-20	D	--	1 / 2	0.002 J		OW-09	D	0.004 J	OW-20	D	DOB
4,4'-DDE	0.005	0.006	--	1 / 4	0.002 J		OW-11	D	--	1 / 3	0.0008 J		OW-13	V	--	1 / 2	0.005 J		OW-09	D	0.005 J	OW-09	D	BR
4,4'-DDD	0.005	0.006	--	0 / 4	--		--	--	--	0 / 3	--		--	--	--	1 / 2	0.0004 J		OW-09	D	0.0004 J	OW-09	D	BR
Endrin	0.005	0.006	--	0 / 4	--		--	--	--	1 / 3	0.002 J		OW-20	D	--	0 / 2	--		--	--	0.002 J	OW-20	D	DOB
gamma-Chlordane	0.003	0.004	--	0 / 4	--		--	--	--	1 / 3	0.0005 J		OW-20	D	--	0 / 2	--		--	--	0.0005 J	OW-20	D	DOB
PCBs (µg/l)																								
None Detected																								
Total Petroleum Hydrocarbons (mg/l)																								
None Detected																								
Metals (µg/l)																								
Aluminum (8)	11.5		--	1 / 4	1,010		OW-12	D	--	1 / 3	2,630		OW-10	D	--	1 / 2	1,970		OW-09	D	2,630	OW-10	D	DOB
Iron (8)	9.7		16,700	3 / 4	1,540	3,790	OW-11	D	88.4	3 / 3	55.8	6,780	OW-20	D	517	2 / 2	475	805	OW-09	D	16,700	MW-208S	U	SOB
Calcium	14.5		7,330	4 / 4	8,080	39,500 J	OW-12	D	26,200	3 / 3	19,300	57,400	OW-20	D	43,400	2 / 2	55,700	122,000 J	OW-09	D	122,000 J	OW-09	D	BR
Magnesium	5.4		1,410	4 / 4	495	1,780	OW-11	D	5,190	3 / 3	4,610	11,300	OW-20	D	8,490	2 / 2	21,000	24,400 J	OW-09	D	24,400 J	OW-09	D	BR
Sodium	150		13,100	4 / 4	5,900	42,000 J	OW-12	D	36,800	3 / 3	29,400	288,000	OW-20	D	17,700	2 / 2	23,600	148,000 J	OW-09	D	288,000	OW-20	D	DOB
Potassium	30.8		1,940 J	4 / 4	1,090 J	7,820	OW-12	D	2,370 J	3 / 3	3,060 J	16,700 J	OW-20	D	3,820 J	2 / 2	5,650 J	10,800	OW-09	D	16,700 J	OW-20	D	DOB
Barium	0.20		34.7 J	3 / 4	8.1 J	62.0 J	OW-21	D	61.0 J	3 / 3	53.3	159 J	OW-20	D	--	2 / 2	35.7	39.1 J	MW-209B	D	159 J	OW-20	D	DOB
Manganese	0.20		1,020	3 / 4	407	688	OW-11	D	1,730	3 / 3	853	4,160	OW-20	D	453	2 / 2	1,100	8,750	OW-09	D	8,750	OW-09	D	BR
Arsenic	2.7		49.6	2 / 4	12.1	23.4	OW-12	D	--	1 / 3	17.3		OW-20	D	--	0 / 2	--		--	--	49.6	MW-208S	U	SOB
Cadmium	0.50		--	0 / 4	--		--	--	--	1 / 3	1.3		OW-10	D	--	1 / 2	2.1		OW-09	D	2.1	OW-09	D	BR
Chromium	0.70		--	0 / 4	--		--	--	--	1 / 3	1.4		OW-13	V	--	0 / 2	--		--	--	1.4	OW-13	V	DOB
Cobalt	0.50		3.9	2 / 4	1.6	3.5	OW-21	D	0.70	3 / 3	4.8	54.7	OW-10	D	0.60	1 / 2	135		OW-09	D	135	OW-09	D	BR
Copper	0.50		--	0 / 4	--		--	--	--	1 / 3	8.7		OW-10	D	--	1 / 2	7.9		OW-09	D	8.7	OW-10	D	DOB
Lead	1.6		3.0	1 / 4	2.0		OW-11	D	1.6 J	0 / 3	--		--	--	2.1	1 / 2	1.7		MW-209B	D	3.0	MW-208S	U	SOB
Nickel	2.4		--	2 / 4	2.4	10.0	OW-21	D	--	3 / 3	8.4	49.9	OW-10	D	--	1 / 2	122		OW-09	D	122	OW-09	D	BR
Silver	0.60		--	1 / 4	0.75		OW-21	D	--	0 / 3	--		--	--	0.63	0 / 2	--		--	--	0.75	OW-21	D	SOB
Vanadium	0.60		1.2	1 / 4	1.0		OW-12	D	--	0 / 3	--		--	--	--	0 / 2	--		--	--	1.2	MW-208S	U	SOB
Zinc	1.2		--	1 / 4	63.4		OW-21	D	--	1 / 3	113		OW-10	D	--	1 / 2	166		OW-09	D	166	OW-09	D	BR
Water Quality Parameters (mg/l)																								
Alkalinity (as $CaCO_3$)	1		83	NA	NA		NA	NA	64	NA	NA		NA	NA	64	NA	NA		NA	NA	83	MW-208S	U	SOB
Hardness	NA		24	4 / 4	22	104 J	OW-12	D	86 88	4 / 4	67	190	OW-20	D	143	2 / 2	226	422 J	OW-09	D	422 J	OW-09	D	BR
Chloride	0.5		13.9	NA	NA		NA	NA	80.9	NA	NA		NA	NA	85.4	NA	NA		NA	NA	85.4	MW-208D	U	DOB
Nitrate/Nitrite as Nitrogen	0.01		0.01	NA	NA		NA	NA	--	NA	NA		NA	NA	0.01	NA	NA		NA	NA	0.01	MW-208S	U	SOB
																						MW-208B	U	BR
Sulfate	5		--	NA	NA		NA	NA	23	NA	NA		NA	NA	25	NA	NA		NA	NA	25	MW-208B	U	BR
Total Phosphorus	0.0050		0.057	NA	NA		NA	NA	0.040	NA	NA		NA	NA	0.032	NA	NA		NA	NA	0.057	MW-208S	U	SOB
Cyanide (µg/l) - None Detected																								
Biochemical Oxygen Demand	1.0		2.1	NA	NA		NA	NA	--	NA	NA		NA	NA	--	NA	NA		NA	NA	2.1	MW-208S	U	SOB
Chemical Oxygen Demand	5		21	NA	NA		NA	NA	14	NA	NA		NA	NA	12	NA	NA		NA	NA	21	MW-208S	U	SOB
Total Dissolved Solids	5		93	NA	NA		NA	NA	275	NA	NA		NA	NA	368	NA	NA		NA	NA	368	MW-208B	U	BR
Total Suspended Solids	0.5		0.5	NA	NA		NA	NA	--	NA	NA		NA	NA	1.3	NA	NA		NA	NA	1.3	MW-208B	U	BR
Total Organic Carbon	0.5		4.9	NA	NA		NA	NA	2.4	NA	NA		NA	NA	--	NA	NA		NA	NA	4.9	MW-208S	U	SOB

TABLE 4-23 (Continued). SUMMARY OF ANALYTES DETECTED IN GROUNDWATER SAMPLES FROM THE ASBESTOS LAGOON (JULY 1995) (1)

			Shallow Overburden						Deep Overburden						Bedrock						Overall Maximum			
	Range of SQLs (2)		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum		Upgradient	Frequency of	Range of Values (5)		Maximum					Flow
Analyte	Min.	Max.	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value (3)	Detection (4)	Min.	Max.	Location	Area (6)	Value	Location	Area	Zone (7)
pH	NA		6.3	4 / 4	6.0	7.8	OW-12	D	6.4	3 / 3	4.3	6.4	OW-20	D	7.0	2 / 2	4.9	6.6	MW-209B	D	7.8	OW-12	U	SOB
Specific Conductance (μmhos/cm)	NA		180	4 / 4	56	320	OW-12	D	360	3 / 3	360	2,500	OW-20	D	400	2 / 2	580	1,900	OW-09	D	2,500	OW-20	D	DOB
Redox Potential (mV)	NA		-20	4 / 4	-293	194	OW-14	V	5.5	3 / 3	-150	176	OW-13	V	-65	2 / 2	-56	192	OW-09	D	194	OW-14	V	SOB
Dissolved Oxygen (mg/l)	NA		14	4 / 4	0.2	3.6	OW-14	V	14	3 / 3	0.4	0.6	OW-20	D	12	2 / 2	0.2	0.7	OW-09	D	14	MW-208S	U	SOB
																						MW-208D	U	DOB
Turbidity (NTU)	NA		120	4 / 4	0	1	OW-11	D	110	3 / 3	0	1	OW-13	V	83	2 / 2	0	3	OW-09	D	120	MW-208S	U	SOB
Temperature (C)	NA		14.1	4 / 4	12.2	15.8	OW-12	D	13.6	3 / 3	13.3	14.6	OW-20	D	15.8	2 / 2	13.8	15.1	MW-209B	D	15.8	OW-12	D	SOB
																						MW-208B	U	BR

NOTES:
1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Upgradient Wells: shallow overburden - MW-208S; Data from upgradient wells presented for comparison of downgradient, source, and vicinity wells. Data for background wells are presented in Table 4-13.
   deep overburden - MW-208D
   bedrock - MW-208B
4. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits.
   Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
5. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included.
   A single concentration is presented when only one positive detection has occurred.
6. "Area" as it is used here indicates source, downgradient, or vicinity areas (S, D, and V, respectively) which are defined relative to the source area presented in this table.
7. Flow Zones: SOB - shallow overburden
   DOB - deep overburden
   BR - bedrock
8. Many results for these analytes were qualified as non-detected during data validation and evaluation. See Sections 2.3.2 and 4.2.2 for discussion of the qualified data.

- Analyte was not detected in samples from this grouping
NA - Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation

TABLE 4-24. SUMMARY OF ANALYTES DETECTED IN SITE-WIDE SURFACE WATER SAMPLES (JUNE AND SEPTEMBER 1993) (1)

			June								September											
	Range of SQLs (2)		Background Range of Values (4)		Frequency of	Arithmetic	Range of Values (4)		Maximum	Area of Maximum	Background Range of Values (4)		Frequency of	Arithmetic	Range of Values (4)		Maximum	Area of Maximum	Overall Maximum			
Analyte	Minimum	Maximum	Minimu	Maximum	Detection (3)	Average	Minimum	Maximum	Location	Location	Minimum	Maximum	Detection (3)	Average	Minimum	Maximum	Location	Location	Value	Location	Area	Round
Volatile Organics (µg/l)																						
Benzene	10		--	--	0 / 44	--	--	--	--	--	--	--	2 / 40	5 *	1 J		SW-310	SLW	1 J	SW-310	SLW	September
Toluene	10		--	--	2 / 44	6	8 J	24	SW-311	SLW	--	--	3 / 40	5	1 J	10	SW-316	RP	24	SW-311	SLW	June
Ethylbenzene	10		--	--	1 / 44	6	42		SW-313	SLW	--	--	0 / 40	--	--	--	--	--	42	SW-313	SLW	June
Total Xylenes	10		--	--	4 / 44	8	11 J	120	SW-313	SLW	--	--	2 / 40	5 *	4 J		SW-310	SLW	120	SW-313	SLW	June
Chlorobenzene	10		--	--	0 / 44	--	--	--			--	--	2 / 40	5 *	1 J	2 J	SW-322	UB	2 J	SW-322	UB	September
Tetrachloroethene	10		--	--	1 / 44	5	16		SW-322	UB	--	--	2 / 40	5	2 J	12	SW-322	UB	16	SW-322	UB	June
Trichloroethene	10		--	--	1 / 44	5	8 J		SW-322	UB	--	--	1 / 40	5	9 J		SW-322	UB	9 J	SW-322	UB	September
1,1,1-Trichloroethane	10		--	--	1 / 44	5	20		SW-322	UB	--	--	5 / 40	5	1 J	17	SW-322	UB	20	SW-322	UB	June
1,2-Dichloroethene(total)	10		--	--	1 / 44	5	11		SW-322	UB	--	--	1 / 40	5	12		SW-322	UB	12	SW-322	UB	September
1,1-Dichloroethane	10		--	--	0 / 44	--	--	--	--	--	--	--	2 / 40	5	2 J	11	SW-322	UB	11	SW-322	UB	September
Methylene Chloride (5)	10		--	--	0 / 44	--	--	--	--	--	--	--	1 / 40	5	10 J		SW-010	UB	10 J	SW-010	UB	September
Chloromethane	10		--	--	0 / 44	--	--	--	--	--	--	--	1 / 40	5 *	3 J		SW-111	RP	3 J	SW-111	RP	September
Carbon Disulfide	10		--	--	0 / 44	--	--	--	--	--	--	--	2 / 40	5	1 J	5 J	SW-317	MMC	5 J	SW-317	MMC	September
Semivolatile Organics (µg/l)	10																					
Naphthalene	10		--	--	7 / 44	4 *	0.40 J	4 J	SW-313	SLW	--	--	0 / 40	--	--	--	--	--	4 J	SW-313	SLW	June
Acenaphthene	10		--	--	2 / 44	5 *	0.50 J	0.90 J	SW-111	RP	--	--	0 / 40	--	--	--	--	--	0.90 J	SW-111	RP	June
Phenanthrene	10		0.6 J		5 / 44	5 *	0.40 J	1 J	SW-310	SLW	--	--	1 / 40	5 *	2 J		SW-111	RP	1 J	SW-310/SW-111	SLW/RP	June/September
Fluoranthene	10		0.6 J		5 / 44	5 *	0.40 J	1 J	SW-310	SLW	1 J		1 / 40	5 *	1 J		SW-111	RP	2 J	SW-111	RP	September
Pyrene	10		0.9 J		6 / 44	4 *	0.60 J	1 J	SW-310	SLW	1 J		2 / 38	5 *	1 J	2 J	SW-111	RP	2 J	SW-111	RP	September
Benzo(a)anthracene	10		--	--	2 / 44	5 *	0.70 J	1 J	SW-310	SLW	--	--	0 / 38	--	--	--	--	--	1 J	SW-310	SLW	June
Chrysene	10		--	--	1 / 44	5 *	1 J		SW-310	SLW	--	--	1 / 38	5 *	1 J		SW-111	RP	1 J	SW-310/SW-111	SLW/RP	June/September
Benzo(b)fluoranthene	10		0.7 J		3 / 44	5 *	1 J	2 J	SW-310	SLW	--	--	0 / 37	--	--	--	--	--	2 J	SW-310	SLW	June
1,4-Dichlorobenzene	10		--	--	2 / 44	5 *	0.60 J	2 J	SW-313	SLW	--	--	1 / 40	5 *	1 J		SW-030	CB	2 J	SW-313	SLW	June
Phenol	10	120	--	--	1 / 44	7	96 J		SW-030	CB	--	--	0 / 40	--	--	--	--	--	96 J	SW-030	CB	June
2-Methylphenol	10		--	--	1 / 44	5 *	2 J		SW-311	SLW	--	--	0 / 40	--	--	--	--	--	2 J	SW-311	SLW	June
4-Methylphenol	10	120	--	--	2 / 44	16	43	440	SW-030	CB	--	--	0 / 40	--	--	--	--	--	440	SW-030	CB	June
2,4-Dimethylphenol	qqqq		--	--	1 / 44	5	7 J	7 J	SW-313	SLW	--	--	0 / 40	--	--	--	--	--	7 J	SW-313	SLW	June
Bis(2-ethylhexyl)phthalate	10	100	0.8 J		4 / 44	9	0.50 J	190 J	SW-311	SLW	--	--	0 / 38	--	--	--	--	--	190 J	SW-311	SLW	June
Pesticides (µg/l)																						
alpha-BHC	0.0025	0.003	--	--	4 / 44	0.0014	0.0010 J	0.0047 J	SW-311	SLW	0.002 J		2 / 38	0.0017	0.0030 J	0.0060 J	SW-310	SLW	0.0060 J	SW-310	SLW	September
delta-BHC	0.0025	0.003	--	--	1 / 44	0.0014	0.0079 J		SW-312	SLW	--	--	1 / 38	0.0019	0.016 J		SW-308	WMC	0.016 J	SW-308	WMC	September
gamma-BHC(Lindane)	0.0025	0.0050	--	--	8 / 43	0.0036	0.0010 J	0.066 J	SW-310	SLW	--	--	0 / 38	--	--	--	--	--	0.066 J	SW-310	SLW	June
4,4'-DDT	0.0050		--	--	3 / 44	0.0033	0.0020 J	0.0041 J	SW-312	SLW	--	--	2 / 38	0.0061	0.0053 J	0.007 J	SW-111	RP	0.007 J	SW-111	RP	September
4,4'-DDD	0.0050		--	--	3 / 44	0.0026	0.0023 J	0.0057 J	SW-310	SLW	--	--	2 / 38	0.0031	0.0040 J	0.025	SW-111	RP	0.025 J	SW-111	RP	September
4,4'-DDE	0.0050		--	--	0 / 44	--	--	--	--	--	0.006 J		0 / 44	--	--	--	--	--	0.006 J	SW-321	BG	September
Methoxychlor	0.025	0.030	--	--	2 / 33	0.013	0.0029 J	0.025 J	SW-106	EMC	--	--	0 / 38	--	--	--	--	--	0.025 J	SW-106	EMC	June
Heptachlor	0.0025	0.0003	--	--	1 / 44	0.0014	0.0086 J		SW-312	SLW	--	--	0 / 38	--	--	--	--	--	0.0086 J	SW-312	SLW	June
Heptachlor Epoxide	0.0025	0.0003	--	--	3 / 43	0.0013	0.0015 J	0.0022 J	SW-311	SLW	--	--	0 / 38	--	--	--	--	--	0.0022 J	SW-311	SLW	June
Endosulfan I	0.0025	0.0003	--	--	3 / 44	0.0013	0.0011 J	0.0014 J	SW-315	RP	--	--	0 / 38	--	--	--	--	--	0.0014 J	SW-315	RP	June
Endosulfan II	0.0050		0.0011 J		6 / 44	0.0024 *	0.0011 J	0.0022 J	SW-320	RP	--	--	1 / 38	0.0026	0.0045 J		SW-111	RP	0.0045 J	SW-111	RP	September
Aldrin	0.0025	0.003	--	--	3 / 44	0.0015	0.0006 J	0.014 J	SW-117	CB	--	--	0 / 17	--	--	--	--	--	0.014 J	SW-117	CB	June
Dieldrin	0.0050		--	--	2 / 44	0.0027	0.0022 J	0.0082 J	SW-312	SLW	--	--	0 / 38	--	--	--	--	--	0.0082 J	SW-312	SLW	June
Endrin	0.0050		--	--	19 / 44	0.0039	0.0017 J	0.021 J	SW-322	UB	--	--	0 / 38	--	--	--	--	--	0.021 J	SW-322	UB	June
Endrin Aldehyde	0.0050		--	--	2 / 44	0.0026	0.0026 J	0.0050 J	SW-322	UB	0.006 J		2 / 38	0.0027	0.0050 J	0.0078 J	SW-111	RP	0.0078 J	SW-111	RP	September
alpha-Chlordane	0.0025	0.003	0.00075 J		4 / 44	0.0012	0.0006 J	0.0014 J	SW-311	SLW	0.009 J		2 / 38	0.0017	0.0043 J	0.0050 J	SW-313	SLW	0.0050 J	SW-313	SLW	September
gamma-Chlordane	0.0025	0.003	--	--	4 / 44	0.0016	0.0022 J	0.0072 J	SW-312	SLW	0.011 J		1 / 38	0.0016	0.00475 J		SW-111	RP	0.0072 J	SW-312	SLW	June
PCBs (µg/l)																						
Aroclor-1248	0.500		--	--	0 / 44	--	--	--	--	--	--	--	1 / 37	0.029	0.17		SW-308	WMC	0.17	SW-308	WMC	September
Aroclor-1260	0.500		--	--	0 / 44	--	--	--	--	--	--	--	1 / 37	0.031	0.24 J		SW-111	RP	0.24 J	SW-111	RP	September
Metals (µg/l)																						
Aluminum	10.6	23.5	1,580	6,290	24 / 44	3,680	129	65,000 J	SW-310	SLW	888	18,500 J	25 / 40	1,980	17.4	41,700 J	SW-111	RP	65,000 J	SW-310	SLW	June
Iron	4.8	9.2	2,970	27,000	44 / 44	70,400	653	1,290,000 J	SW-030	CB	2,830	71,200 J	40 / 40	14,700	329	116,000 J	SW-111	RP	1,290,000 J	SW-030	CB	June
Calcium	24.2	93.7	11,000	24,800	44 / 44	32,800	3,330	226,000	SW-030	CB	9,980	27,900	40 / 40	25,100	7,280	98,800	SW-313	SLW	226,000	SW-030	CB	June
Magnesium	22.9	46.4	2,530	4,930	44 / 44	8,660	942	75,300	SW-310	SLW	2,120	6,570	40 / 40	7,450	1,610	50,200	SW-313	SLW	75,300	SW-310	SLW	June
Sodium	37.0	114.4	26,200	37,200	44 / 44	72,900	10,100	333,000	SW-310	SLW	23,000	23,100 J	40 / 40	90,900	12,600	673,000	SW-312	SLW	673,000	SW-312	SLW	September
Potassium	68.5	187.6	2,190	3,530	44 / 44	12,900	996	113,000	SW-310	SLW	2,480	4,500	40 / 40	12,700	1,160	130,000	SW-313	SLW	130,000	SW-313	SLW	September
Barium	1.0	3.6	33.1	155	44 / 44	452	9.3	10,300	SW-030	CB	37.7	285	39 / 40	135	17.2	842	SW-303	RWA	10,300	SW-030	CB	June
Manganese	0.6	1.8	350	5,840	43 / 44	1,590	129 J	13,500 J	SW-030	CB	315	6,740	40 / 40	883	59.4	3,530	SW-308	WMC	13,500 J	SW-030	CB	June
Beryllium	0.2	0.5	1.1		1 / 44	0.35	4.3		SW-311	SLW	2.8		2 / 40	0.18	0.40	1.6 J	SW-111	RP	4.3	SW-311	SLW	June
Antimony	9.2	18.6	--	--	3 / 44	10.2	20.2	30.2	SW-310	SLW	--	--	2 / 40	6.9	14.0	14.4	SW-116	EMC	30.2	SW-310	SLW	June
Arsenic	1.7	2.8	18.1 J		28 / 44	380	1.8	13,000	SW-030	CB	39.8 J		16 / 40	43.6	2.5	676	SW-030	CB	13,000	SW-030	CB	June

TABLE 4-24 (Continued). SUMMARY OF ANALYTES DETECTED IN SITE-WIDE SURFACE WATER SAMPLES (JUNE AND SEPTEMBER 1993) (1)

			June								September											
	Range of SQLs (2)		Background Range of Values (4)		Frequency of	Arithmetic	Range of Values (4)		Maximum	Area of Maximum	Background Range of Values (4)		Frequency of	Arithmetic	Range of Values (4)		Maximum	Area of Maximum	Overall Maximum			
Analyte	Minimum	Maximum	Minimum	Maximu	Detection (3)	Average	Minimum	Maximum	Location	Location	Minimum	Maximum	Detection (3)	Average	Minimum	Maximum	Location	Location	Value	Location	Area	Round
Metals (Continued) (µg/l)																						
Cadmium	1.0	1.7	--	--	0 / 44	--	--	--	--	--	--	--	1 / 40		28.2		SW-303	RWA	28.2	SW-303	RWA	September
Chromium	1.8	5.8	3.5	9.9	10 / 44	9.1	4.3	133	SW-310	SLW	25.9		9 / 40	6.2	3.4	92.3 J	SW-111	RP	133	SW-310	SLW	June
Cobalt	1.5	3.8	33.2		9 / 44	6.2	5.5	58.0	SW-311	SLW	72.5		8 / 40	3.3	4.3	27.7	SW-303	RWA	58.0	SW-311	SLW	June
Copper	2.2	4.2	--	--	4 / 44	11.0	26.5	166	SW-311	SLW	7.8		4 / 40	27.6	3.7	636	SW-303	RWA	636	SW-303	RWA	September
Lead	0.8	2.9	22.3 J	40.9	14 / 44	32.0	16.6 J	632	SW-311	SLW	32.4	122 J	13 / 40	52.9	10.9 J	630	SW-303	RWA	632	SW-303	SLW	June
Mercury	0.1	0.2	--	--	3 / 44	0.06	0.15	0.18	SW-302	RWA	--	--	1 / 40	0.10	0.27		SW-312	SLW	0.27	SW-312	SLW	September
Nickel	3.4	6.1	5.1	18.6	22 / 44	12.4	4.3	134	SW-311	SLW	48.2		5 / 40	15.0	28.4	324 J	SW-303	RWA	324 J	SW-303	RWA	September
Selenium	2.3	3.7	--	--	7 / 44	2.8	2.4	27.6	SW-030	CB	--	--	2 / 40	1.6	4.0 J	6.1 J	SW-111	RP	27.6	SW-030	CB	June
Silver	2.6	3.8	--	--	4 / 44	4.5	14.2	54.0	SW-030	CB	--	--	3 / 40	2.0	5.1	9.2	SW-111	RP	54.0	SW-030	CB	June
Thallium	1.1	2.2	--	--	1 / 44	2.1	23.8		SW-030	CB	2.9		3 / 40	1.1	2.1 J	2.9	SW-305	DD	23.8	SW-030	CB	June
Vanadium	2.1	5.5	19.0		10 / 44	13.5	2.8	211 J	SW-310	SLW	49.1		10 / 40	7.2	3.4	102	SW-111	RP	211 J	SW-310	SLW	June
Zinc	3.4	8.5	27.8	158	16 / 44	66.5	14.6 J	1,160	SW-311	SLW	66.6	505	9 / 40	217	12.9	5,100	SW-303	RWA	5,100	SW-303	RWA	September
Water Quality Parameters (mg/l)																						
Alkalinity (as $CaCO_3$)	1.0		30	41	43 / 44	111	1.0	845	SW-312	SLW	12.0	34.0	40 / 40	122	2.0	900	SW-313	SLW	900	SW-313	SLW	September
Hardness	--		38	82	44 / 44	118	12.0	857	SW-310	SLW	34.0	97.0	40 / 40	93.0	25.0	453	SW-313	SLW	857	SW-310	SLW	June
Cyanide (µg/l) - None Detected																						
Total Organic Carbon	0.50		11.0 J	18	44 / 44	40.3	7.1 J	341	SW-030	CB	8.0	18.0	40 / 40	14.0	3.7	67.0 J	SW-313	SLW	341	SW-030	CB	June
Field Quality Parameters																						
pH	NA		6.6	7	42 / 42	6.5	5.9	7.4	SW-312	SLW	7.2	8.7	40 / 40	6.7	4.7	7.8	SW-313	SLW	7.8	SW-313	SLW	September
Specific Conductance	NA		200		44 / 44	1,800	25.0	24,000	SW-013	UB	200	280	40 / 40	650	120	7,600	SW-030	CB	24,000	SW-013	UB	June
Dissolved Oxygen	NA		2.9		44 / 44	4.1	0.60	8.5	SW-010	UB	6.0	6.5	40 / 40	4.7	1.0	8.2	SW-105	EMC	8.5	SW-010	UB	June
Temperature	NA		19.6	19.7	43 / 43	19.9	14.0	27.2	SW-312	SLW	14.0	15.0	38 / 38	17.3	12.2	25.0	SW-313	SLW	27.2	SW-319	SLW	June

NOTES:
1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included. A single concentration is presented when only one positive detection has occurred.
5. Although summary data are presented, these analytes are not considered to be site-related as discussed in sections 2.3.2 and 4.2.3.

* - The calculated average is greater than the maximum value.
-- Analyte was not detected in samples from this grouping.
NA - Not Applicable
J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation.
DD - Drainage Ditch
SLW - Shaffer Landfill Wetlands
UB - Unnamed Brook
RP - Richardson Pond
CB - Content Brook
EMC - East of Middlesex Canal
WMC - West of Middlesex Canal
MMC - Manmade Canal
RWA - RSI Wetland Area

TABLE 4-25. SUMMARY OF ANALYTES DETECTED IN SITE-WIDE SEDIMENT SAMPLES (JUNE AND SEPTEMBER 1993) (1)

Analyte	Range of SQLs (2) Minimum	Range of SQLs (2) Maximum	June: Background Range of Values (4) Minimum	June: Background Range of Values (4) Maximu	June: Frequency of Detection (3)	June: Arithmetic Average	June: Range of Values (4) Minimum	June: Range of Values (4) Maximum	June: Maximum Location	June: Area of Maximum Location	September: Background Range of Values (4) Minimum	September: Background Range of Values (4) Maximum	September: Frequency of Detection (3)	September: Arithmetic Average	September: Range of Values (4) Minimum	September: Range of Values (4) Maximum	September: Maximum Location	September: Area of Maximum Location	Overall Maximum Value	Overall Maximum Location	Overall Maximum Area	Overall Maximum Round
Volatile Organics (µg/kg)																						
Benzene	11	120	--	--	6 / 49	16	7 J	54 J	SD-022	RP	--	--	3 / 30	13	3 J	19 J	SD-310	SLW	54 J	SD-022	RP	June
Toluene	11	120	--	--	11 / 49	25	13 J	200	SD-309	RP	--	--	4 / 31	14	4 J	41 J	SD-102	CB	200	SD-309	RP	June
Ethylbenzene	11	120	--	--	3 / 49	25	28	440	SD-310	SLW	--	--	2 / 30	13	14 J	30	SD-310	SLW	440	SD-310	SLW	June
Total Xylenes	11	120	--	--	7 / 49	41	9 J	990	SD-022	RP	--	--	4 / 30	28	9 J	410	SD-310	SLW	990	SD-022	RP	June
Chlorobenzene	11	120	--	--	1 / 49	16	39		SD-030	CB	--	--	3 / 31	13 *	4 J	9 J	SD-301	RWA	39	SD-030	CB	June
Acetone (5)	11	120	--	--	22 / 49	40	7 J	200 J	SD-315	RP	--	--	1 / 30	62	500 J		SD-111	RP	500 J	SD-111	RP	September
2-Butanone (5)	11	120	--	--	9 / 49	19	15 J	110	SD-304	BMP	120 J		13 / 36	40	16 J	300 J	SD-304	BMP	300 J	SD-304	BMP	September
2-Hexanone	11	120	--	--	0 / 49	--	--	--	--	--	31 J		0 / 30	--	--	--	--	--	31 J	SD-321	BG	September
1,1,2,2-Tetrachloroethane	11	120	--	--	2 / 49	18	80		SD-310	SLW	--	--	0 / 30	--	--	--	--	--	80	SD-310	SLW	June
																				SD-022	RP	June
1,1,1-Trichloroethane	11	120	--	--	0 / 49	--	--	--	--	--	--	--	1 / 31	13 *	10 J		SD-104	EMC	10 J	SD-104	EMC	September
1,2-Dichloroethene(total)	11	120	--	--	1 / 49	16	70		SD-309	RP	--	--	0 / 30	--	--	--	--	--	70	SD-309	RP	June
Methylene Chloride (5)	11	120	--	--	1 / 49	15	18 J		SD-102	CB	--	--	0 / 30	--	--	--	--	--	18 J	SD-102	CB	June
Chloromethane	11	120	--	--	0 / 49	--	--	--	--	--	--	--	1 / 30	13	14 J		SD-103	EMC	14 J	SD-103	EMC	September
Bromomethane	11	120	--	--	0 / 49	--	--	--	--	--	--	--	1 / 30	14	44		SD-103	EMC	44	SD-103	EMC	September
Semivolatile Organics (µg/kg)																						
Naphthalene	380	91,000	--	--	21 / 49	4,000 *	19 J	2,300 J	SD-118	UB	--	--	12 / 33	580 *	61 J	450 J	SD-310	SLW	2,300 J	SD-118	SLW	June
2-Methylnaphthalene	380	91,000	--	--	11 / 49	3,800 *	21 J	1,500 J	SD-118	UB	--	--	9 / 33	600 *	59 J	240 J	SD-317	MMC	1,500 J	SD-118	MMC	June
Acenaphthylene	380	91,000	--	--	5 / 49	4,100 *	20 J	2,200 J	SD-118	UB	--	--	1 / 33	620 *	180 J		SD-102	CB	2,200 J	SD-118	CB	June
Acenaphthene	380	91,000	--	--	10 / 49	4,300	28 J	4,600 J	SD-111	RP	--	--	10 / 34	610	44 J	6,600 J	SD-111	RP	6,600 J	SD-111	RP	September
Fluorene	380	91,000	--	--	12 / 49	3,800 *	39 J	3,700 J	SD-111	RP	--	--	12 / 34	640	87 J	6,600 J	SD-111	RP	6,600 J	SD-111	RP	September
Phenanthrene	380	91,000	46 J	65 J	33 / 49	4,700	19 J	36,000 J	SD-118	UB	--	--	19 / 35	1,500	44 J	32,000	SD-111	RP	36,000 J	SD-118	UB	June
Anthracene	380	91,000	--	--	14 / 49	4,000	25 J	5,200 J	SD-118	UB	--	--	9 / 34	610	78 J	6,400 J	SD-111	RP	6,400 J	SD-111	RP	September
Fluoranthene	380	91,000	67 J	85 J	34 / 49	5,100	23 J	48,000 J	SD-118	UB	--	--	25 / 37	1,600	56 J	33,000	SD-111	RP	48,000 J	SD-118	UB	June
Pyrene	380	91,000	91 J	110 J	34 / 49	6,000	17 J	62,000 J	SD-118	UB	130 J		27 / 37	2,000	68 J	48,000 J	SD-111	RP	62,000 J	SD-118	UB	June
Benzo(a)anthracene	380	91,000	42 J	42 J	22 / 49	4,900	38 J	40,000 J	SD-118	UB	--	--	16 / 34	1,000	86 J	18,000	SD-111	RP	40,000 J	SD-118	UB	June
Chrysene	380	91,000	39 J	58 J	27 / 49	4,400	19 J	25,000 J	SD-118	UB	--	--	20 / 37	1,000	110 J	20,000	SD-111	RP	25,000 J	SD-118	UB	June
Benzo(b)fluoranthene	380	91,000	72 J	110 J	27 / 49	5,300	35 J	60,000 J	SD-118	UB	--	--	18 / 35	770	81 J	11,000 J	SD-111	RP	60,000 J	SD-118	UB	June
Benzo(k)fluoranthene	380	91,000	--	--	8 / 49	4,200 *	110 J	3,000 J	SD-109	NSC	--	--	17 / 33	860	73 J	13,000 J	SD-111	RP	13,000 J	SD-111	RP	September
Benzo(a)pyrene	380	91,000	34 J		16 / 49	4,400	36 J	18,000 J	SD-118	UB	290 J		19 / 34	900	62 J	15,000	SD-111	RP	18,000 J	SD-118	UB	June
Dibenz(a,h)anthracene	380	91,000	--	--	2 / 49	4,200 *	220 J	1,400 J	SD-111	RP	--	--	8 / 32	520	84 J	3,000 J	SD-111	RP	3,000 J	SD-111	RP	September
Benzo(g,h,i)perylene	380	91,000	48 J		5 / 49	4,300	56 J	6,200 J	SD-111	RP	--	--	12 / 32	710	44 J	9,000 J	SD-111	RP	9,000 J	SD-111	RP	September
Indeno(1,2,3-cd)pyrene	380	91,000	40 J		10 / 49	4,300	38 J	18,000 J	SD-118	UB	--	--	12 / 32	670	54 J	7,700 J	SD-111	RP	18,000 J	SD-118	UB	June
1,2-Dichlorobenzene	380	91,000	--	--	1 / 49	4,400 *	750 J		SD-013	UB	--	--	0 / 33	--	--	--	--	--	750 J	SD-013	UB	June
1,4-Dichlorobenzene	380	91,000	--	--	1 / 49	4,400 *	230 J		SD-013	UB	--	--	1 / 33	620 *	77 J		SD-312	SLW	230 J	SD-013	UB	June
Dibenzofuran	380	91,000	--	--	10 / 49	3,900 *	35 J	1,600 J	SD-118	UB	--	--	10 / 34	440	50 J	1,300 J	SD-111	RP	1,600 J	SD-118	UB	June
N-Nitrosodiphenylamine	380	91,000	--	--	1 / 49	4,400 *	270 J	270 J	SD-304	BMP	--	--	3 / 33	620 *	100 J	300 J	SD-010	UB	300 J	SD-010	UB	September
4-Methylphenol	380	91,000	--	--	9 / 49	4,100 *	50 J	2,900 J	SD-118	UB	--	--	4 / 34	600 *	76 J	400 J	SD-314	RP	2,900 J	SD-118	UB	June
Bis(2-ethylhexyl)phthalate	380	91,000	140 J		26 / 49	4,100	58 J	17,000 J	SD-118	UB	--	--	2 / 33	780	2,200	2,600	SD-312	SLW	17,000 J	SD-118	UB	June
Butylbenzylphthalate	380	91,000	--	--	2 / 49	4,400 *	41 J	1,800 J	SD-304	BMP	--	--	4 / 36	630	260 J	910 J	SD-315	RP	1,800 J	SD-304	BMP	June
Bis(2-chloroethyl)ether	380	91,000	--	--	1 / 49	4,400 *	550 J		SD-013	UB	--	--	0 / 33	--	--	--	--	--	550 J	SD-013	UB	June
Carbazole	380	91,000	--	--	5 / 49	4,100 *	31 J	2,300 J	SD-118	UB	--	--	4 / 33	610 *	45 J	270 J	SD-102	CB	2,300 J	SD-118	UB	June
Pesticides (µg/kg)																						
alpha-BHC	1.9	32	--	--	3 / 49	2.5 *	0.25 J	0.46 J	SD-326	AL	--	--	0 / 33	--	--	--	--	--	0.46 J	SD-326	AL	June
beta-BHC	1.9	32	0.48 J		4 / 49	2.2 *	0.19 J	1.4 J	SD-311	SLW	--	--	0 / 33	--	--	--	--	--	1.4 J	SD-311	SLW	June
delta-BHC	1.9	32	0.19 J	0.24 J	8 / 49	2.1	0.13 J	3.3 J	SD-304	BMP	--	--	0 / 33	--	--	--	--	--	3.3 J	SD-304	BMP	June
gamma-BHC(Lindane)	1.9	32	--	--	2 / 49	2.6	0.23 J	8.3 J	SD-304	BMP	--	--	0 / 33	--	--	--	--	--	8.3 J	SD-304	BMP	June
4,4'-DDE	3.8	62	3.2 J	10	45 / 49	5.3	0.09 J	47 J	SD-304	BMP	--	--	3 / 33	4.2	4.8	12 J	SD-022	RP	47 J	SD-304	BMP	June
4,4'-DDD	3.8	62	11	12	37 / 49	8.3	0.23 J	83 J	SD-304	BMP	--	--	4 / 34	5.0	4.6 J	23 J	SD-028	WMC	83 J	SD-304	BMP	June
4,4'-DDT	3.8	62	0.64 J		5 / 49	4.2 *	0.28 J	1.6 J	SD-314	RP	--	--	1 / 33	3.8	9.6 J		SD-022	RP	9.6 J	SD-022	RP	September
Methoxychlor	19	320	--	--	14 / 49	18	0.22 J	26 J	SD-108	RWA	--	--	1 / 33	19 *	14 J		SD-102	CB	26 J	SD-108	RWA	June
Heptachlor	1.9	32	--	--	1 / 49	2.5 *	0.54 J		SD-030	CB	--	--	0 / 33	--	--	--	--	--	0.54 J	SD-030	CB	June
Heptachlor Epoxide	1.9	32	--	--	20 / 49	1.6	0.11 J	3.1 J	SD-324	AL	--	--	0 / 33	--	--	--	--	--	3.1 J	SD-324	AL	June
Endosulfan I	1.9	32	1.1 J		15 / 49	1.9	0.21 J	3.4 J	SD-309	RP	--	--	0 / 33	--	--	--	--	--	3.4 J	SD-309	RP	June
Endosulfan II	3.8	62	--	--	14 / 49	3.8	0.14 J	9.4	SD-313	SLW	--	--	0 / 33	--	--	--	--	--	9.4	SD-313	SLW	June
Endosulfan Sulfate	3.8	62	--	--	6 / 49	4.2 *	0.30 J	1.8 J	SD-111	RP	--	--	0 / 33	--	--	--	--	--	1.8 J	SD-111	RP	June
Aldrin	1.9	32	--	--	4 / 49	2.4 *	0.08 J	2.4 J	SD-320	RP	--	--	0 / 33	--	--	--	--	--	2.4 J	SD-320	RP	June
Dieldrin	3.8	62	0.11 J	0.87 J	25 / 49	3.6	0.14 J	10 J	SD-307	WMC	--	--	5 / 33	4.8	5.8 J	17 J	SD-010	UB	17 J	SD-010	UB	September
Endrin	3.8	62	--	--	18 / 49	4.5	0.12 J	14 J	SD-111	RP	--	--	2 / 33	4.1	7.1 J	15 J	SD-303	RWA	15 J	SD-303	RWA	September

TABLE 4-25 (Continued). SUMMARY OF ANALYTES DETECTED IN SITE-WIDE SEDIMENT SAMPLES (JUNE AND SEPTEMBER 1993) (1)

Analyte	Range of SQLs (2)		June								September								Overall Maximum			
			Background Range of Values (4)		Frequency of	Arithmetic	Range of Values (4)		Maximum	Area of Maximum	Background Range of Values (4)		Frequency of	Arithmetic	Range of Values (4)		Maximum	Area of Maximum				
	Minimum	Maximum	Minimum	Maximu	Detection (3)	Average	Minimum	Maximum	Location	Location	Minimum	Maximum	Detection (3)	Average	Minimum	Maximum	Location	Location	Value	Location	Area	Round
Pesticides (continued) (µg/kg)																						
Endrin Aldehyde	3.8	62	--	--	3 / 49	9.0	8.2 J	190 J	SD-304	BMP	--	--	0 / 33	--	--	--	--	--	190 J	SD-304	BMP	June
Endrin Ketone	3.8	62	--	--	7 / 49	4.5 *	0.16 J	3.7 J	SD-013	UB	--	--	0 / 33	--	--	--	--	--	3.7 J	SD-013	UB	June
alpha-Chlordane	1.9	32	1.6 J		11 / 49	2.3	0.17 J	18 J	SD-109	NSC	--	--	2 / 34	2.3	3.4 J	13 J	SD-028	WMC	18 J	SD-109	NSC	June
gamma-Chlordane	1.9	32	1.8 J		23 / 49	1.7	0.13 J	18 J	SD-109	NSC	--	--	0 / 33	--	--	--	--	--	18 J	SD-109	NSC	June
PCBs (µg/kg)																						
Aroclor-1016	38	620	9.6 J		2 / 49	50 *	2.2 J	4.4 J	SD-026	WMC	--	--	0 / 33	--	--	--	--	--	4.4 J	SD-026	WMC	June
Aroclor-1232	38	620	--	--	3 / 49	51	3.8	170 J	SD-315	RP	--	--	0 / 33	--	--	--	--	--	170 J	SD-315	RP	June
Aroclor-1242	38	620	--	--	8 / 49	51	6.8 J	220	SD-111	RP	--	--	0 / 33	--	--	--	--	--	220	SD-111	RP	June
Aroclor-1248	38	650	36 J		13 / 49	99	9.1	2,000	SD-308	WMC	--	--	3 / 35	74	310 J	620 J	SD-028	WMC	2,000	SD-308	WMC	June
Aroclor-1254	38	620	--	--	4 / 49	54	20 J	320	SD-317	MMC	--	--	0 / 33	--	--	--	--	--	320	SD-317	MMC	June
Aroclor-1260	38	620	--	--	2 / 49	62	260	340	SD-313	SLW	--	--	0 / 33	--	--	--	--	--	340	SD-313	SLW	June
Metals (mg/kg)																						
Aluminum	3.5	43.0	5,300	14,800 J	49 / 49	6,450	1,150 J	26,300	SD-111	RP	2,130	10,300	41 / 41	7,530	1,160 J	32,300	SD-310	SLW	32,300	SD-310	SLW	September
Iron	1.0	29.0	6,260 J	6,590	49 / 49	12,200	1,670 J	76,300	SD-030	CB	1,340 J	5,080	41 / 41	12,300	1,580 J	50,200 J	SD-317	MMC	76,300	SD-030	CB	June
Calcium	5.5	172	1,490	6,070	48 / 49	19,500	410	215,000	SD-325	AL	3,340 J	4,050	33 / 41	3,050	532	11,100 J	SD-304	BMP	215,000	SD-325	AL	June
Magnesium	6.5	85.0	1,120 J	1,760	49 / 49	2,180	307 J	9,700	SD-111	RP	500 J	1,520	41 / 41	2,140	173	10,500	SD-310	SLW	10,500	SD-310	SLW	September
Sodium	8.8	82.7	--	--	4 / 42	563	1,700	13,000	SD-318	SP	--	--	3 / 35	335	1,670 J	2,190 J	SD-314	RP	13,000	SD-318	SP	June
Potassium	22.3	344	323 J	1,040	41 / 46	931	303	4,600	SD-111	RP	374		33 / 39	987	277	7,400	SD-310	SLW	7,400	SD-310	SLW	September
Barium	0.3	9.3	26.1	59.1 J	49 / 49	60.9	11.9	287	SD-111	RP	30.7 J	39.1	41 / 41	58.1	8.2	270	SD-111	RP	287	SD-111	RP	June
Manganese	0.2	3.3	98.7	469 J	49 / 49	402	24.4 J	2,700	SD-105	EMC	32.7 J	388	41 / 41	327	18.3	2,750 J	SD-028	WMC	2,750 J	SD-028	WMC	September
Beryllium	0.04	2.2	2.7 J		11 / 47	0.61	0.80	3.7	SD-108	RWA	1.3		8 / 34	0.43	0.51	3.8 J	SD-029	WMC	3.8 J	SD-029	WMC	September
Antimony	2.1	34.1	--	--	6 / 40	4.9	4.1	26.3 J	SD-317	MMC	--	--	3 / 32	7.5	3.2 J	158 J	SD-118	UB	158 J	SD-118	UB	September
Arsenic	0.4	4.4	5.0 J	5.2	46 / 46	16.6	1.6 J	256	SD-030	CB	--	--	31 / 40	17.5	2.8	142	SD-030	CB	256	SD-030	CB	June
Cadmium	0.2	2.8	--	--	3 / 39	0.45	1.3	3.4 J	SD-304	BMP	--	--	4 / 33	0.41	0.48	5.4 J	SD-029	WMC	5.4 J	SD-029	WMC	September
Chromium	0.8	9.5	14.2 J		17 / 43	17.0	12.0 J	106 J	SD-304	BMP	16.4 J		13 / 37	19.0	13.8	100 J	SD-028	WMC	106 J	SD-304	BMP	June
Cobalt	0.6	5.3	6.2 J		29 / 45	6.5	2.3 J	24.0 J	SD-304	BMP	4.8		20 / 37	7.6	3.2	48.6 J	SD-029	WMC	48.6 J	SD-029	WMC	September
Copper	0.6	7.5	16.9 J		31 / 46	116	7.6	3,600 J	SD-317	MMC	12.8	20.6 J	28 / 40	92.3	6.6 J	2,120 J	SD-317	MMC	3,600 J	SD-317	MMC	June
Lead	0.2	5.2	19.8 J	43.0	49 / 49	142	3.6 J	2,970 J	SD-317	MMC	17.4	18.8 J	39 / 41	140	3.7 J	1,590 J	SD-317	MMC	2,970 J	SD-317	MMC	June
Mercury	0.1	0.47	0.29 J		20 / 45	0.19	0.06	0.99	SD-111	RP	0.16		18 / 36	0.15	0.07	1.3	SD-111	RP	1.3	SD-111	RP	September
Nickel	0.9	8.8	--	--	6 / 44	10.6	13.1 J	132	SD-109	NSC	--	--	13 / 36	13.0	14.6	52.1 J	SD-029	WMC	132	SD-109	NSC	June
Selenium	0.5	4.3	--	--	21 / 42	1.6	0.61 J	10.2 J	SD-317	MMC	--	--	8 / 35	1.3	0.97 J	7.2 J	SD-029	WMC	10.2 J	SD-317	MMC	June
Silver	0.8	6.0	--	--	5 / 39	1.0	0.83	6.7	SD-030	CB	--	--	0 / 32	--	--	--	--	--	6.7	SD-030	CB	June
Vanadium	0.5	5.0	11.3 J	14.4	47 / 47	16.8	5.8	76.4	SD-111	RP	7.2 J	9.5	40 / 40	19.1	2.7	110 J	SD-029	WMC	110 J	SD-029	WMC	September
Zinc	0.7	13.6	38.1 J	46.4	38 / 46	108	20.2	998 J	SD-304	BMP	26.3	28.6 J	33 / 39	104	7.8 J	634 J	SD-317	MMC	998 J	SD-304	BMP	June
Soil Quality Parameters (mg/kg)																						
Cyanide	0.6	4.4	--	--	2 / 38	0.54	0.89	1.2	SD-118	UB	--	--	0 / 32	--	--	--	--	--	1.2	SD-118	UB	June
Total Petroleum Hydrocarbons	12	1,500	--	--	29 / 45	290	14	3,400	SD-109	NSC	75 J		25 / 41	150	14 J	2,500	SD-322	UB	3,400	SD-109	NSC	June
Total Organic Carbon	60	100	--	--	6 / 6	70,000	20,000	99,000	SD-118	UB	--	--	5 / 5	39,000	32,000 J	53,000	SD-105	EMC	99,000	SD-118	UB	June
Geotechnical Parameters (%)																						
Total Combustible Organics	--	--	12	43	47 / 47	25	1.1	94	SD-314	RP	30	79	41 / 41	18	1.2	93	SD-314/315	RP	94	SD-314	RP	June
Soil Moisture Content	--	--	92	364	51 / 51	51	11	90	SD-108	RWA	239	816	43 / 43	51	0	90	SD-029	WMC	90	SD-108	RWA	June
																				SD-029	WMC	September

NOTES:
1. Analytical data is presented in Appendix F.
2. SQLs - Sample Quantitation Limit; which is often referred to as the sample-specific detection limit or sample reporting limit.
3. Frequency of detection is the number of samples with positive values. Positive values include approximated values and approximated values less than sample quantitation limits. Number of samples include all analyzed samples for which analytical values were reported, unless the sample value was rejected.
4. Presents the minimum and maximum values for positive detections. Approximated values and approximated values less than sample quantitation limits are also included. A single concentration is presented when only one positive detection has occurred.
5. Although summary data are presented, these analytes are not considered to be site-related as discussed in sections 2.3.2 and 4.2.4.

* - The calculated average is greater than the maximum value.

-- Analyte was not detected in samples from this grouping.

NA - Not Applicable

J - Quantitation is approximate due to limitations identified during laboratory analysis or data validation.

TABLE 4-26. COMPARISON OF TOTAL ORGANIC CARBON AND TOTAL COMBUSTIBLE ORGANICS IN SEDIMENTS

Sample Date	Area	Location	Total Organic Carbon (%)	Total Combustible Organics (%)
06/09/93	Unnamed Brook	SD-118	9.9	8.2
06/09/93	Unnamed Brook	SD-322	2.0	2.2
06/11/93	Drainage Ditch	SD-305	6.2	4.8
06/14/93	RSI Wetland Area	SD-016	6.05	13.9
06/22/93	Asbestos Lagoons	SD-323	9.45	30.1
06/22/93	Asbestos Lagoons	SD-324	8.6	28.7
09/14/93	Unnamed Brook	SD-118	3.8	10
09/14/93	Unnamed Brook	SD-322	3.15 J	3.38
09/16/93	Drainage Ditch	SD-305	3.9	2.98
09/16/93	RSI Wetland Area	SD-016	3.3	2.46
09/22/93	Middlesex Canal (East of Pond Street)	SD-105	5.3	7.26

NOTES:
NA – Not Analyzed
J – Quantitation limit is approximate due to limitations identified during laboratory analysis or data validation.

TABLE 4-27. GROUNDWATER MCL EXCEEDANCES - B&M RAILROAD LANDFILL

Analyte(1)	MCL(2) (µg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (µg/l)	Location of Maximum	Maximum Upgradient (µg/l)	Maximum Background (µg/l)
Analytes Detected in March/April 1995							
No exceedances of MCLs in March/April 1995							
Analytes Detected in July 1995							
1,1-Dichloroethene	7		0 / 13	4	MW-213B,MW-213D	ND	ND
1,2-Dichloroethane	5		2 / 13	8	OW-49	ND	ND
1,2-Dichloroethene(total)	100	(3)	0 / 13	8	OW-49	ND	ND
Arsenic	50		0 / 13	39.7	MW-214S	3.8	48.5
Barium	2,000		0 / 13	2,000	MW-213S	10.5	27.1
Chlorobenzene	100		0 / 13	4	MW-213D	ND	ND
Chloroform	100	(4)	0 / 13	4	MW-215B	ND	ND
Chromium	100		0 / 13	5.4	MW-213S	ND	0.95
Lead	15	(5)	1 / 13	21.7	MW-213S	ND	ND
Toluene	1,000		0 / 13	4	MW-213S	ND	ND
Trichloroethene	5		3 / 13	39	MW-213B,MW-213D	ND	ND

NOTES:

1. General water quality parameters, such as nitrate, are not listed
2. Maximum Contaminant Levels proumulgated under the federal Safe Drinking Water Act
3. The MCL for trans-1,2-dichlorethene is 100 µg/l. The MCL for cis-1,2-dichlorethene is 70 µg/l. No MCL is stated for total dichlorethene
4. The MCL for total trihalomethanes is 100 µg/l. No MCL is stated for individual compounds
5. Action Level

TABLE 4-28. GROUNDWATER MCL EXCEEDANCES - RSI LANDFILL

Analyte(1)	MCL(2) (µg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (µg/l)	Location of Maximum	Maximum Upgradient (µg/l)	Maximum Background (µg/l)
			Analytes Detected in March/April 1995				
1,1,1-Trichloroethane	200		0 / 13	--	--	3	ND
1,1-Dichloroethene	7		0 / 13	--	--	2	ND
1,2-Dichloroethane	5		0 / 13	3	MW-212B	6	ND
1,2-Dichloroethene(total)	100	(3)	0 / 13	8	OW-07	ND	ND
Aroclor-1232	0.5	(4)	0 / 13	0.05	OW-07	ND	ND
Aroclor-1260	0.5	(4)	0 / 13	0.08	OW-01, MW-212D	ND	0.02
Arsenic	50		2 / 13	345	MW-211D	36.1	45.2
Barium	2,000		0 / 13	83.2	MW-211D	324	14.9
Benzene	5		1 / 13	345	OW-08	ND	ND
Bis (2-ethylhexyl)phthalate	6		0 / 13	--	--	4	ND
Chlorobenzene	100		0 / 13	3	MW-210S, OW-01	ND	ND
Chromium	100		0 / 13	20.6	OW-07	ND	ND
Copper	1,300	(5)	0 / 13	34.7	OW-07	5.9	32.6
Cyanide	200		0 / 4	--	--	112	ND
Endrin	2		0 / 13	--	--	0.0002	ND
gamma-Chlordane	2	(6)	0 / 13	0.0005	OW-01	ND	ND
Heptachlor epoxide	0.2		0 / 13	0.002	OW-01	ND	ND
Lead	15	(5)	1 / 13	25.2	OW-07	ND	12.5
Methoxychlor	40		0 / 13	0.01	MW-210S	0.008	ND
Selenium	50		0 / 13	5.6	MW-211S	ND	ND
Tetrachloroethene	5		0 / 13	--	--	3	ND
Thallium	2		1 / 13	8.9	MW-211D	9	ND
Total xylenes	10,000		0 / 13	9.5	OW-08	ND	ND
Trichloroethene	5		1 / 13	23	OW-07	3	ND
gamma-BHC(Lindane)	0.2		0 / 13	0.003	MW-211D	ND	ND
			Analytes Detected in July 1995				
1,2-Dichloroethane	5		0 / 13	3	MW-212B	5.5	ND
1,2-Dichloroethene(total)	100	(3)	0 / 13	4	OW-07	ND	ND
1,4-Dichlorobenzene	75		0 / 13	3	OW-08	ND	ND
Arsenic	50		2 / 13	277.5	MW-211D	33.7	48.5
Barium	2,000		0 / 13	149	MW-211S	419	27.1

TABLE 4-28 (Continued). GROUNDWATER MCL EXCEEDANCES - RSI LANDFILL

Analyte(1)	MCL(2) (μg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (μg/l)	Location of Maximum	Maximum Upgradient (μg/l)	Maximum Background (μg/l)
Benzene	5		1 / 13	350	OW-08	ND	ND
Cadmium	5		0 / 13	--	--	2	ND
Chromium	100		0 / 13	--	--	0.825	0.95
Cyanide	200	(7)	0 / 13	--	--	208	ND
Endrin	2		0 / 13	0.001	OW-07	ND	ND
Lead	15	(5)	0 / 13	--	--	2	ND
Tetrachloroethene	5		0 / 13	--	--	3	ND
Total xylenes	10,000		0 / 13	13	OW-08	ND	ND
Trichloroethene	5		1 / 13	21	OW-07	3	ND

NOTES:

1. General water quality parameters, such as nitrate, are not listed
2. Maximum Contaminant Levels promulgated under the federal Safe Drinking Water Act
3. The MCL for trans-1,2-dichlorethene is 100 μg/l. The MCL for cis-1,2-dichlorethene is 70 μg/l. No MCL is stated for for total dichlorethene.
4. The MCL for decachlorobiphenyl is 0.5 μg/l. No MCL is stated for individual PCB compounds
5. Action Level
6. MCL for chlordane is 2 μg/l. No MCL is stated for individual chlordane compounds
7. The MCL for cyanide was exceeded at upgradient well: deep overburden OW-25

--not detected/not applicable

TABLE 4-29. GROUNDWATER MCL EXCEEDANCES - B&M LOCOMOTIVE SHOP DISPOSAL AREAS

Analyte(1)	MCL(2) (μg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (μg/l)	Location of Maximum	Maximum Upgradient (μg/l)	Maximum Background (μg/l)
Analytes Detected in March/April 1995							
No exceedances of MCLs in March/April 1995							
Analytes Detected in July 1995							
No exceedances of MCLs in March/April 1995							

NOTES:
1. General water quality parameters, such as nitrate, are not listed
2. Maximum Contaminant Levels proumulgated under the federal Safe Drinking Water Act
3. The MCL for trans-1,2-dichlorethene is 100 μg/l. The MCL for cis-1,2-dichlorethene is 70 μg/l. No MCL is stated for total dichlorethene
4. The MCL for total trihalomethanes is 100 μg/l. No MCL is stated for individual compounds
5. Action Level

TABLE 4-30. GROUNDWATER MCL EXCEEDANCES – OLD B&M OIL/SLUDGE RECYCLING AREA

Analyte(1)	MCL(2) (µg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (µg/l)	Location of Maximum	Maximum Upgradient (µg/l)	Maximum Background (µg/l)
Analytes Detected in March/April 1995							
1,1,1-Trichloroethane	200		0 / 14	6	MW-203D	12	ND
Arsenic	50		0 / 14	27.1	OW-19	13.1	48.5
Barium	2,000		0 / 14	122	OW-37	39.1	27.1
Bis (2-ethylhexyl)phthalate	6		0 / 14	5	OW-19	ND	ND
Cadmium	5		0 / 14	--	--	0.55	ND
Chromium	100		0 / 14	4.7	OW-41	ND	0.95
Copper	1,300	(3)	0 / 14	60.9	MW-203B	15.3	ND
Endrin	2		0 / 14	0.0008	MW-203D	ND	ND
Lead	15	(3)	0 / 14	2.8	MW-203B	2.3	ND
gamma-Chlordane	2	(4)	0 / 14	0.001	MW-203S	ND	ND
Analytes Detected in July 1995							
1,1-Dichloroethene	7		2 / 13	9	MW-213B	ND	ND
1,2-Dichloroethane	5		2 / 13	9	MW-213B	ND	ND
1,2-Dichloroethene(total)	100	(5)	0 / 13	5	OW-49	ND	ND
Antimony	6		0 / 13	--	--	4.7	ND
Aroclor-1242	0.5	(6)	0 / 13	0.04	MW-213S	ND	ND
Aroclor-1248	0.5	(6)	0 / 13	0.15	MW-214S	ND	ND
Aroclor-1254	0.5	(6)	0 / 13	0.02	MW-213S	ND	ND
Aroclor-1260	0.5	(6)	0 / 13	0.03	MW-213S	0.06	0.02
Arsenic	50		1 / 13	55.6	MW-214S	ND	45.2
Barium	2,000		0 / 13	1340	MW-213S	12.1	14.9
Bis (2-ethylhexyl)phthalate	6		1 / 13	9	MW-215B	ND	ND
Chlorobenzene	100		0 / 13	4	MW-213D	ND	ND
Chloroform	100	(7)	0 / 13	6	MW-215B	ND	ND
Chromium	100		0 / 13	16.2	OW-50	ND	ND
Copper	1,300		0 / 13	57.8	MW-213S	8.3	32.6
Heptachlor epoxide	0.2		0 / 13	0.001	MW-214D	ND	ND
Lead	15	(3)	1 / 13	32.7	MW-213S	ND	12.5
Methoxychlor	40		0 / 13	0.02	MW-213S	ND	ND
Toluene	1,000		0 / 13	3	MW-213S	ND	ND

TABLE 4-30 (Continued). GROUNDWATER MCL EXCEEDANCES - OLD B&M OIL/SLUDGE RECYCLING AREA

Analyte (1)	MCL (2) (µg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (µg/l)	Location of Maximum	Maximum Upgradient (µg/l)	Maximum Background (µg/l)
Trichloroethene	5		3 / 13	53	MW-213D	ND	ND
alpha-Chlordane	2	(4)	0 / 13	0.001	MW-213S	ND	ND
gamma-Chlordane	2	(4)	0 / 13	0.002	MW-214S	ND	ND

NOTES:

1. General water quality parameters, such as nitrate, are not listed
2. Action Level
3. Maximum Contaminant Levels promulgated under the federal Safe Drinking Water Act
4. The MCL for chlordane is 2 µg/l. MCLs are not available for individual chlordane compounds
5. The MCL for trans-1,2-dichlorethene is 100 µg/l. The MCL for cis-1,2-dichlorethene is 70 µg/l. No MCL is stated for total dichlorethene.
6. The MCL for decachlorobiphenyl is 0.5 µg/l. No MCL is stated for individual compounds
7. The MCL for total trihalomethanes is 100 µg/l. No MCL is stated for individual compounds

-- not detected/not applicable

TABLE 4-31. GROUNDWATER MCL EXCEEDANCES - ASBESTOS LAGOON

Analyte(1)	MCL(2) (μg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (μg/l)	Location of Maximum	Maximum Upgradient (μg/l)	Maximum Background (μg/l)
			Analytes Detected in March/April 1995				
1,2-Dichloroethane	5		1 / 9	38	MW-209B	4	ND
Aroclor-1221	0.5	(3)	0 / 9	0.1	OW-09	ND	ND
Aroclor-1254	0.5	(3)	0 / 9	--	--	0.008	ND
Aroclor-1260	0.5	(3)	0 / 9	--	--	ND	0.02
Arsenic	50		0 / 9	16.1	OW-12	58.1	45.2
Barium	2,000		0 / 9	158	OW-20	61.2	4.9
Beryllium	4		0 / 9	2.4	OW-10	ND	ND
Bis (2-ethylhexyl)phthalate	6		0 / 9	3	OW-10, OW-11	13	ND
Chromium	100		0 / 9	8.2	OW-12	ND	ND
Copper	1,300	(4)	0 / 9	22.4	OW-12	ND	32.6
Heptachlor epoxide	0.2		0 / 9	0.005	OW-09, OW-20	0.002	ND
Lead	15	(4)	2 / 9	63.6	OW-12	ND	12.5
Nickel	100		0 / 9	99.1	OW-09	ND	ND
alpha-Chlordane	2	(5)	0 / 9	0.001	OW-09	ND	ND
gamma-Chlordane	2	(5)	0 / 9	0.0007	OW-20	ND	ND
			Analytes Detected in July 1995				
1,2-Dichlorobenzene	600		0 / 9	2	OW-09	ND	ND
1,2-Dichloroethane	5		1 / 9	39	MW-209B	3	ND
Arsenic	50		0 / 9	23.4	OW-12	49.6	48.5
Barium	2,000		0 / 9	159	OW-20	61.0	27.1
Cadmium	5		0 / 9	2.1	OW-09	ND	ND
Chromium	100		0 / 9	1.4	OW-13	ND	0.95
Copper	1,300	(4)	0 / 9	8.7	OW-10	ND	ND
Endrin	2		0 / 9	0.002	OW-20	ND	ND
Lead	15	(4)	0 / 9	2	OW-11	3	ND
Nickel	100		1 / 9	121.5	OW-09	ND	ND
gamma-Chlordane	2	(5)	0 / 9	0.0005	OW-20	ND	ND

NOTES:
1. General water quality parameters, such as nitrate, are not listed
2. Maximum Contaminant Levels promulgated under the federal Safe Drinking Water Act
2. The MCL for total PCBs (as decachlorobiphenyl) is 0.5 μg/l. MCLs are not available for specific Aroclors
3. Action Level
4. The MCL for chlordane is 2 μg/l. MCLs are not available for individual chlordane compounds
-- not detected/not applicable

TABLE 4-32 SURFACE WATER MCL EXCEEDANCES

Analyte	MCL(1) (μg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (μg/l)	Location of Maximum	Maximum Background (μg/l)
Analytes Detected in June 1993						
1,1,1-Trichloroethane	200		0 / 44	20	SW-322	ND
1,2-Dichloroethene(total)	100	(2)	0 / 44	11	SW-322	ND
1,4-Dichlorobenzene	75		0 / 44	2	SW-313	ND
Antimony	6		3 / 44	30.2	SW-310	ND
Arsenic	50		7 / 44	13,000	SW-030	18.1
Barium	2,000		2 / 44	10,300	SW-030	155
Beryllium	4		1 / 44	4.3	SW-311	1.1
Bis (2-ethylhexyl)phthalate	6		0 / 44	190	SW-311	0.8
Chromium	100		1 / 44	133	SW-310	9.9
Copper	1,300	(3)	0 / 44	166	SW-311	ND
Endrin	2		0 / 44	0.021	SW-322	ND
Ethylbenzene	700		0 / 44	42	SW-313	ND
Heptachlor	0.4		0 / 44	0.0086	SW-312	ND
Heptachlor epoxide	0.2		0 / 43	0.0022	SW-311	ND
Lead	15	(3)	14 / 44	632	SW-311	40.9
Mercury	2		0 / 44	0.18	SW-302	ND
Methoxychlor	40		0 / 33	0.025	SW-106	ND
Selenium	50		0 / 44	27.6	SW-030	ND
Tetrachloroethene	5		1 / 44	16	SW-322	ND
Thallium	2		1 / 44	23.8	SW-030	ND
Toluene	1,000		0 / 44	24	SW-311	ND
Total xylenes	10,000		0 / 44	120	SW-313	ND
Trichloroethene	5		1 / 44	8	SW-322	ND
alpha-Chlordane	2	(4)	0 / 44	0.0014	SW-311	0.0007
gamma-BHC(Lindane)	0.2		0 / 43	0.066	SW-310	ND
gamma-Chlordane	2	(4)	0 / 44	0.0072	SW-112	ND

TABLE 4-32 (Continued). SURFACE WATER MCL EXCEEDANCES

Analyte	MCL(1) (μg/l)	MCL Notes	Frequency > MCL	Maximum Concentration (μg/l)	Location of Maximum	Maximum Background (μg/l)
			Analytes Detected in September 1993			
1,1,1-Trichloroethane	200		0 / 40	17	SW-322	ND
1,2-Dichloroethene(total)	100	(2)	0 / 40	12	SW-322	ND
1,4-Dichlorobenzene	75		0 / 40	1	SW-030	ND
Antimony	6		2 / 40	14.4	SW-116	ND
Aroclor-1248	0.5	(5)	0 / 37	0.17	SW-308	ND
Aroclor-1260	0.5	(5)	0 / 37	0.24	SW-111	ND
Arsenic	50		6 / 40	676	SW-030	39.8
Barium	2,000		0 / 40	842	SW-303	285
Benzene	5		0 / 40	1	SW-310, BW-320	ND
Beryllium	4		0 / 40	1.6	SW-111	2.8
Cadmium	5		1 / 40	28.2	SW-303	ND
Chlorobenzene	100		0 / 40	2	SW-322	ND
Chromium	100		0 / 40	92.3	SW-111	25.9
Copper	1,300	(3)	0 / 40	636	SW-303	7.8
Lead	15	(3)	12 / 40	630	SW-303	122
Mercury	2		0 / 40	0.27	SW-312	ND
Methylene chloride	5		1 / 40	10	SW-010	ND
Selenium	50		0 / 40	6.1	SW-111	ND
Tetrachloroethene	5		1 / 40	12	SW-322	ND
Thallium	2		3 / 40	2.9	SW-305	2.9
Toluene	1,000		0 / 40	10	SW-316	ND
Total xylenes	10,000		0 / 40	4	SW-310, SW-312	ND
Trichloroethene	5		1 / 40	9	SW-322	ND
alpha-Chlordane	2	(4)	0 / 38	0.0050	SW-313	0.009
gamma-Chlordane	2	(4)	0 / 38	0.00475	SW-111	0.011

NOTES:
1. Maximum Contaminant Levels promulgated under the federal Safe Drinking Water Act
2. The MCL for trans-1,2-dichlorethene is 100 μg/l. The MCL for cis-1,2-dichlorethene is 70 μg/l. No MCL is stated for total dichlorethene.
3. Action Level
4. The MCL for chlordane is 2 μg/l. MCLs are not available for individual chlordane compounds
5. The MCL for decachlorobiphenyl is 0.5 μg/l. None stated for individual compounds

TABLE 5-1. CHEMICAL AND PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS DETECTED DURING THE RI

	Molecular Weight	Kow (Log)	Solubility in Water (mg/l)	Koc (ml/g)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mol)	Density (g/cm^3)
REFERENCES:		(1,3,4,5,7,9,12,14)	(1,2,3,4,5,7,9,10,12,14)	(1,3,6,7,9,12,14)	(1,3,4,5,6,7,9,10,14)	(1,3,6,7,9,10,12,14)	(4,8,9,13,14)
Volatile Organics							
Benzene	78	1.56 to 2.13	1.00E+03 to 1.79E+03	4.80E+00 to 9.20E+02	4.55E+01 to 9.51E+01	5.43E-03 to 5.59E-03	0.876 to 0.879
Toluene	92	2.69 to 2.79	2.20E+02 to 5.35E+02	3.74E+01 to 3.00E+02	2.20E+01 to 3.74E+01	5.93E-03 to 6.66E-03	0.867
Ethylbenzene	106	3.15	1.52E+02 to 2.06E+02	2.50E+02 to 1.10E+03	7.00E+00 to 1.25E+01	6.43E-03 to 8.43E-03	0.867
Xylenes (Total) (1)	106	2.94 to 6.62	1.46E+02 to 2.13E+02	4.77E+01 to 9.28E+02	2.55E+00 to 1.00E+01	4.945E-03 to 8.04E-03	0.86 to 0.880
Chlorobenzene	113	2.63	4.48E+02 to 5.00E+02	1.00E+00 to 6.00E+02	1.17E+01 to 8.80E+00	3.46E-03 to 3.93E-03	1.106
Styrene	104	2.95	3.00E+02 to 3.20E+02	9.20E+02	5.00E+00 to 6.40E+00	2.61E-03 to 2.83E-03	0.906
1,2-Dichlorobenzene (2)	166	3.38 to 3.60	1.00E+02 to 1.45E+02	1.70E+03	9.60E-01 to 1.00E+01	1.88E-03 to 2.00E-03	1.3
1,4-Dichlorobenzene (2)	147	3.52 to 3.60	7.90E+01 to 1.37E+02	3.20E+02 to 6.00E+04	6.00E-01 to 1.18E+00	1.58E-03 to 2.89E-03	1.2475
Acetone	58	-0.24	miscible	2.20E+00 to 1.80E+01	1.86E+02 to 2.70E+02	2.06E-05 to 3.97E-05	0.7899
4-Methyl-2-pentanone	100	1.19	1.90E+04 to 2.00E+04	1.90E+01	1.60E+00 to 1.99E+01	1.38E-04	0.7978
2-Butanone	72	0.26 to 0.29	1.36E+05 to 2.68E+05	4.50E+00 to 5.20E+00	7.06E+01 to 9.53E+01	2.74E-05 to 5.77E-05	0.8054
2-Hexanone	100	1.38	2.00E+04 to 3.50E+04	NDA	1.16E+01	2.82E-05	0.83
Isophorone (2)		1.70	1.20E+04	NDA	3.80E-01	5.75E-06	0.9229
Carbon Disulfide	76	1.70 to 4.16	1.19E+03 to 2.94E+03	5.40E+01	1.27E+02 to 3.60E+02	1.22E-03 to 3.03E-02	1.2632
Bromomethane	95	1.10	1.30E+04	NDA	1.40E+03	1.30E-02	1.6755
Chloromethane	50	0.91 to 0.95	4.80E+03 to 7.25E+03	7.40E+01	4.30E+03 to 4.31E+03	8.82E-03 to 4.40E+0	0.916
Chloroethane	65	1.55	5.74E+03	1.70E+01	1.00E+03	1.10E-02	0.9214
Vinyl Chloride	63	1.38	2.67E+03	5.70E+01	2.30E+03 to 2.66E+03	8.19E-02 to 6.95E-01	0.9106
Chloroform	119	1.97	7.95E+03 to 1.06E+04	3.10E+01 to 8.00E+01	9.70E+01 to 2.60E+02	2.87E-03 to 3.75E-03	1.4832 to 1.485
1,1-Dichloroethane	99	1.79	5.06E+03 to 5.50E+03	3.00E+01 to 4.00E+01	1.82E+02 to 3.08E+02	4.31E-03 to 5.70E-03	1.168
1,2-Dichloroethane	99	1.48	8.69E-01 to 8.69E+03	1.40E+01 to 8.00E+01	6.10E+01 to 3.24E+02	9.79E-04 to 4.50E-02	1.25 to 1.253
1,1-Dichloroethene	202	1.84 to 2.13	2.25E+03 to 5.00E+03	6.50E+01 to 3.43E+02	5.00E+02 to 7.78E+02	1.50E-02 to 1.90E-01	1.218
1,2-Dichloroethene	97	0.48 to 0.70	3.50E+03 to 6.30E+03	4.90E+01 to 5.90E+01	5.30E+00 to 3.24E+02	4.05E-03 to 7.58E-02	1.2565 to 1.2837
Methylene chloride	85	0.95 to 1.3	20E+03	8.80E+00 to 3.50E+01	2.25E+02 to 5.99E+02	2.03E-03	1.3326
1,1,1-Trichloroethane	133	1.4 to 2.5	9.50E+02 to 1.50E+03	1.04E+02 to 1.79E+02	1.00E+02 to 1.68E+02	4.08E-03 to 2.76E-02	1.3376
Trichloroethene	131	1.42 to 2.42	1.10E+03	8.72E+01 to 1.50E+02	5.78E+01 to 7.40E+01	8.92E-03 to 2.00E-02	1.464 to 1.465
1,1,2,2-Tetrachloroethane	168	2.39	2.90E+03	1.18E+02	4.90E+00 to 5.00E+00	3.81E-04 to 5.00E-04	1.5953
Tetrachloroethene	166	1.17 to 3.40	1.49E+02 to 2.00E+02	2.00E+02 to 3.64E+02	1.40E+01 to 1.86E+01	1.84E-02 to 8.29E-01	1.62 to 1.63
Semivolative Organics							
Naphthalene	128	3.30 to 3.37	3.00E+01 TO 3.44E+01	8.71E+02 to 9.40E+04	4.92E-02 to 2.30E-01	4.26E-04 to 1.15E-03	1.152
2-Methylnaphthalene	131	-1.89 to 4.10	2.45E+01	1.30E+03 to 8.50E+03	NDA	NDA	NDA
Acenaphthylene	152	3.70 to 3.94	3.93E+00 to 1.61E+01	9.47E+02 to 2.50E+03	9.12E-04 to 2.90E-02	1.13E-05 to 1.48E-03	0.8988
Acenaphthene	154	3.92 to 4.33	3.42E+00 to 3.90E+00	2.07E+03 to 4.60E+03	1.55E-03 to 2.00E-02	9.20E-05 to 2.41E-04	1.024 to 1.225
Fluorene	116	4.18 to 4.20	1.69E+00 to 1.98E+00	3.26E+03 to 7.30E+03	7.10E-04 to 1.80E+01	6.42E-05 to 1.17E-04	1.203
Phenanthrene	178	-1.43 to 4.46	1.00E+00 to 1.29E+00	1.40E+04 to 2.30E+04	1.12E-04 to 6.80E-04	2.28E-05 to 1.59E-04	0.980
Anthracene	178	-1.46 to 4.45	4.34E-02 to 7.48E-02	6.40E+03 to 5.10E+05	2.67E-06 to 1.95E-04	6.50E-05 to 1.02E-03	1.24 to 1.283
Fluoranthene	202	4.90 to 5.33	2.06E-01 to 2.60E-01	1.20E+04 to 3.80E+04	1.23E-08 to 6.00E-06	1.26E-08 to 6.46E-06	1.252
Pyrene	202	4.88 to 5.32	1.32E-01 to 1.40E-01	5.97E+03 to 1.30E+05	6.85E-07 to 2.50E-06	5.04E-06 to 1.10E-05	1.271
Benzo(a)anthracene	228	5.60	5.70E-03 to 1.40E-02	1.38E+06	5.00E-09 to 2.20E-08	1.16E-06	1.0058

TABLE 5-1 (Continued). CHEMICAL AND PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS DETECTED DURING THE RI

	Molecular Weight	Kow (Log)	Solubility in Water (mg/l)	Koc (ml/g)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m³/mol)	Density (g/cm³)
REFERENCES:		(1,3,4,5,7,9,12,14)	(1,2,3,4,5,7,9,10,12,14)	(1,3,6,7,9,12,14)	(1,3,4,5,6,7,9,10,14)	(1,3,6,7,9,10,12,14)	(4,8,9,13,14)
Semivolative Organics (Continued)							
Chrysene	228	5.61 to 5.66	1.50E-03 to 1.40E-02	1.33E+05 to 2.00E+05	5.00E-09 to 6.30E-09	1.05E-06 to 9.46E-05	1.274
Benzo(b)fluoranthene	252	5.06 to 6.84	1.20E-03 to 1.40E-02	1.56E+04 to 5.50E+05	5.00E-07 to 5.50E-04	1.19E-05 to 1.11E-04	NDA
Benzo(k)fluoranthene	252	6.06 to 6.12	5.50E-04 to 4.30E-03	5.10E+04 to 5.50E+05	9.65E-10 to 5.50E-07	4.00E-07 to 3.94E-05	NDA
Benzo(a)pyrene	252	5.97 to 6.06	1.20E-03 to 3.80E-03	5.07E+06 to 5.50E+06	5.49E-09 to 5.00E-07	4.90E-07 to 1.13E-04	1.351
Dibenz(a,h)anthracene	278	2.29 to 6.84	5.00E-04 to 2.49E-03	5.65E+05 to 3.30E+06	1.00E-10 to 5.00E-09	7.33E-08 to 1.15E-04	NDA
Benzo(g,h,i)perylene	276	6.51 to 7.23	2.60E-04 to 7.00E-04	4.06E+05 to 1.60E+06	1.00E-10 to 1.05E-10	5.34E-08 to 1.60E-06	1.282
Indeno(1,2,3-c,d)pyrene	276	6.50 to 7.66	2.20E-05 to 6.20E-02	1.90E+04 to 1.60E+06	1.00E-10	6.86E-08 to 1.60E-06	NDA
Diethylphthalate	222	1.22 to 6.32	8.69E+02 to 1.08E+03	9.80E+01 to 1.42E+02	1.65E-03 to 3.50E-03	4.50E-07 to 1.14E-06	NDA
Di-n-butylphthalate	278	4.72 to 5.60	1.12E+01 to 3.25E+01	1.80E+03 to 1.70E+05	1.00E-05 to 1.60E-04	2.82E-07 to 4.50E-06	NDA
Bis(2-ethylhexyl)phthalate	391	3.98 to 5.30	2.85E-01 to 1.30E+00	8.74E+04	6.20E-08 to 9.75E-06	3.61E-07 to 1.00E-04	0.985 to 0.986
Di-n-octylphthalate	391	5.22	3.00E+00	2.39E+03	2.60E-06	4.45E-07	NDA
Butylbenzylphthalate	312	4.91	2.69E+00 to 2.90E+00	1.70E+04	3.40E-06 to 8.60E-06	1.20E-06 to 1.26E-06	NDA
Phenol	94	1.46	9.30E+04	1.42E+01 to 3.10E+03	3.41E-01 to 5.29E-01	3.33E-07 to 1.89E-05	1.0567 to 1.07
2-Methylphenol	108	1.95	2.60E+04	2.19E+01 to 1.03E+02	2.99E-01	1.20E-06	1.0273
4-Methylphenol	108	1.94 to 1.97	3.10E-02 to 3.10E+04	1.90E+01 to 2.67E+04	1.10E-01 to 3.75E-01	7.92E-07 to 1.10E-06	1.03 to 1.038
2,4-Dimethylphenol	122	2.42	1.70E+01	9.60E+01	6.00E-03 to 6.70E-03	6.70E-06 to 5.67E-04	NDA
4-Chloro-3-methylphenol	143	NDA	NDA	NDA	NDA	NDA	NDA
Pentachlorophenol	266	5.00 to 5.12	2.00 to 2.00E+01	5.30E+04	1.10E-04	2.75E-06 to 3.40E-06	1.978
Bis(2-chloroethyl)ether	143	1.50	1.02E+04	1.39E+01	7.10E-01	1.30E-05 to 1.13E-04	NDA
N-Nitrosodiphenylamine	198	NDA	NDA	NDA	6.30E-04	1.40E-06	NDA
3-Nitroaniline	138	1.37	8.90E+02	NDA	NDA	NDA	1.430
Dibenzofuran	168	4.12	3.10E+00	8.13E+03	NDA	1.26E-05	1.089
Carbazole	167	NDA	NDA	NDA	NDA	NDA	NDA
Pesticides							
alpha-BHC	291	3.90	1.63E+00	3.80E+03	2.50E-05	5.87E-06	NDA
beta-BHC	291	3.90	2.40E-01	3.80E+03	2.80E-07	4.47E-07	NDA
delta-BHC	291	4.10	3.14E+01	6.60E+03	1.70E-05	2.07E-07	NDA
gamma-BHC(Lindane)	291	3.90	7.80E+00	1.08E+03	1.60E-04	7.85E-06	NDA
4,4'-DDD	320	6.20	1.00E-01	7.70E+05	1.89E-06	7.96E-06	1.385
4,4'-DDE	318	7.00	4.00E-02	4.40E+06	6.50E-06	6.80E-05	NDA
4,4'-DDT	354	6.19	5.00E-03	2.43E+05	5.50E-06	5.13E-04	0.98 to 0.99
Methoxychlor	346	4.68	4.00E-02	8.00E+04	NDA	NDA	1.41
Heptachlor	373	4.40	1.80E-01	1.20E+04	3.00E-04	8.19E-04 to 1.48E-03	1.57 to 1.59
Heptachlor Epoxide	389	2.70	3.50E-01	2.20E+02	3.00E-04	3.20E-05 to 4.39E-04	NDA
Endosulfan I	407	3.55	1.60E-01	NDA	1.00E-05	3.35E-05	NDA
Endosulfan II	407	3.62	7.00E-02	NDA	1.00E-05	7.65E-05	NDA
Endosulfan Sulfate	423	3.66	1.60E-01	NDA	NDA	2.6E-05	NDA
Aldrin	365	5.30	1.80E-01 to 2.00E-01	9.60E+04	6.00E-06	1.60E-05 to 4.96E-04	NDA
Dieldrin	381	3.50	1.86E-01 to 1.95E-01	1.70E+03	1.78E-07 to 3.10E-06	2.00E-07 to 5.80E-05	1.75

TABLE 5-1 (Continued). CHEMICAL AND PHYSICAL PROPERTIES OF ORGANIC COMPOUNDS DETECTED DURING THE RI

	Molecular Weight	Kow (Log)	Solubility in Water (mg/l)	Koc (ml/g)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m³/mol)	Density (g/cm³)
REFERENCES:		(1,3,4,5,7,9,12,14)	(1,2,3,4,5,7,9,10,12,14)	(1,3,6,7,9,12,14)	(1,3,4,5,6,7,9,10,14)	(1,3,6,7,9,10,12,14)	(4,8,9,13,14)
Pesticides (Continued)							
Endrin	381	5.16 to 5.339	1.90E+02 to 6.25E+02	4.16	2.00E-07	4.17E-06	1.65
Endrin Aldehyde	381	5.6	2.60E+02	4.43	2.00E-07	3.86E-06	NDA
Endrin Ketone	NDA	NDA	NDA	NDA	NDA	NDA	NDA
alpha-Chlordane	410	5.54	5.60E-01	1.40E+05	1.00E-05	4.85E-05	1.59 to 1.63
gamma-Chlordane	410	3.22 to 5.54	5.60E-02 to 1.85E+00	3.10E+03 to 1.40E+05	3.00E-06 to 2.9E-05	9.63E-06 to 4.85E-05	NDA
PCBs							
Aroclor-1016	256	5.6	4.2E-01	NDA	4.00E-04	2.94E-04	1.3 to 1.5
Aroclor-1221	201	4.7	5.9E-01	NDA	6.70E-03	3.5E-03	1.3 to 1.5
Aroclor-1232	232	5.1	NDA	NDA	4.06E-03	NDA	1.3 to 1.5
Aroclor-1242	267	5.6	1.0E-01 to 3.4E-01	NDA	4.06E-04	5.2E-04	1.3 to 1.5
Aroclor-1248	300	6.2	6.0E-02 to 5.4E-02	NDA	4.94E-04	2.8E-03	1.3 to 1.5
Aroclor-1254	328	6.5	1.2E+02 to 5.7E+02	NDA	7.71E-05	4.05E-03	NDA
Aroclor-1260	376	6.8	2.7E+03 to 8.0E+02	NDA	4.10E-05	1.00E-05 to 1.00E-03	NDA

NOTES:
1. Data for the individual o-, m-, and p- forms are also presented
2. Analyte is grouped with the volatile organics because of similar chemical and physical properties and behavior in the environment; however, analyte was reported as a semivola

NDA - No Data Available
NA - Not Applicable

REFERENCES:

1. U.S. EPA (1986)
2. GRI (1987a)
3. Washeleski (1988)
4. Clement (1985)
5. U.S. EPA (1979)
6. GRI (1987b)
7. Syracuse Research Corporation (1991)
8. Weast and Astle (1981-1982)
9. ASTDR (1987 - 1990)
10. Warner et. al. (1987)
11. Fujita et. al. (1964)
12. Howard (1990a and b)

TABLE 5-2. CHEMICAL AND PHYSICAL PROPERTIES OF METALS DETECTED DURING THE RI

	Molecular Weight	Physical State	Solubility in Water	Solubility in Organics	Solubility in Acids	Specific Gravity
REFERENCES:			(1,2,3,4,5,6)	(2,4,5,6)	(2,4,5,6)	(2,4,5,6)
Aluminum	27	solid	insoluble	NDA	soluble	2.702
Iron	56	solid	insoluble	insoluble	insoluble	7.86
Calcium	40	solid	decomposes	variable	soluble	1.54
Magnesium	24	solid	insoluble	insoluble	variable	1.74
Sodium	23	solid	decomposes	variable	NDA	0.97
Potassium	39	solid	decomposes	variable	soluble	0.86
Barium	137	solid	decomposes	variable	NDA	3.51
Manganese	55	solid	decomposes	NDA	soluble	7.20
Beryllium	9	solid	insoluble	NDA	soluble	1.85
Antimony	122	solid	insoluble	NDA	soluble	6.684 to 6.688
Arsenic	75	solid	insoluble	NDA	soluble	5.727
Cadmium	112	solid	insoluble	variable	soluble	8.642
Chromium	52	solid	insoluble	insoluble	soluble	7.20
Cobalt	59	solid	insoluble	insoluble	soluble	8.9
Copper	64	solid	insoluble	NDA	soluble	8.92
Lead	207	solid	insoluble	insoluble	soluble	11.344
Mercury	201	liquid	insoluble	soluble	variable	15.594
Nickel	59	solid	insoluble	NDA	soluble	8.90
Selenium	79	solid	insoluble	soluble	soluble	4.26 to 4.81
Silver	108	solid	insoluble	soluble	NDA	10.5
Thallium	204	solid	insoluble	NDA	soluble	11.85
Vanadium	51	solid	insoluble	NDA	soluble	5.96
Zinc	65	solid	insoluble	NDA	soluble	7.14

NOTES:
NDA – No Data Available

REFERENCES:

1. U.S.EPA (1986)
2. Clement (1985)
3. U.S.EPA (1979)
4. Weast and Astle (1981–1982)
5. ASTDR (1987–1990)
6. CRC (1972–1973)

TABLE 6-1. SURFACE SOIL SAMPLE GROUPINGS

Grouping Name	Samples
Background	SS-11 through SS-13
B&M Railroad Landfill	SS-61 through SS-74
RSI Landfill	SS-05 through SS-10
B&M Locomotive Shop Disposal Areas	SS-01 through SS-04, and SD-318
Old B&M Oil/Sludge Recycling Area	SS-78 through SS-83
Contaminated Soil Area	SS-14 through SS-59

TABLE 6-2. SEDIMENT SAMPLE GROUPINGS

Grouping Name	Samples
Background	SD-319, SD-321
West Middlesex Canal Area	SD-026, SD-028, SD-029, SD-109, SD-307, SD-308, SD-323, SD-324, SD-325, SD-326
Central Wetlands Area	SD-010, SD-013, SD-118, SD-317, SD-322, SD-016, SD-017, SD-107, SD-108, SD-301, SD-302, SD-303, SD-304, SD-305, SD-306
East Middlesex Canal and Wetlands Area	SD-019, SD-103, SD-104, SD-105, SD-106, SD-116, SD-022, SD-111, SD-113, SD-309, SD-314, SD-315, SD-316, SD-320, SD-020, SD-030, SD-101, SD-102, SD-117, SD-310, SD-313

TABLE 6-3. SURFACE WATER SAMPLE GROUPINGS

Grouping Name	Samples
Background	SW-319, SW-321
West Middlesex Canal Area	SW-026, SW-028, SW-029, SW-109, SW-307, SW-308
Central Wetlands Area	SW-010, SW-013, SW-118, SW-317, SW-322, SW-016, SW-017, SW-107, SW-108, SW-301, SW-302, SW-303, SW-304, SW-305, SW-306
East Middlesex Canal and Wetlands Area	SW-019, SW-103, SW-104, SW-105, SW-106, SW-116, SW-022, SW-111, SW-113, SW-309, SW-314, SW-315, SW-316, SW-320, SW-020, SW-030, SW-101, SW-102, SW-117, SW-310, SW-313

TABLE 6-4. GROUNDWATER WELL GROUPINGS

Grouping Name	Well Depth	Wells
Background	Shallow Overburden	MW-200S
	Deep Overburden	MW-200D
	Bedrock	MW-200B, OW-05
B&M Railroad Landfill	Shallow Overburden	MW-1C, MW-213S, MW-214S, MW-215S, OW-36
	Deep Overburden	MW-1A, MW-213D, MW-214D, MW-215D, OW-35, OW-50
	Bedrock	MW-213B, MW-214B, MW-215B, OW-34, OW-49
RSI Landfill	Shallow Overburden	MW-210S, MW-211S, MW-212S, OW-03, OW-08, OW-26, OW-27
	Deep Overburden	MW-211D, MW-212D, OW-02, OW-07, OW-25
	Bedrock	MW-207B, MW-210B, MW-211B, MW-212B, OW-01
B&M Locomotive Shop Disposal Area	Shallow Overburden	MW-204S, MW-205S, MW-206S, OW-40
	Deep Overburden	MW-204D, MW-205D, MW-206D, OW-39
	Bedrock	MW-204B, MW-205B, MW-206B
Old B&M Oil/Sludge Recycling Area	Shallow Overburden	MW-201S, MW-202S, MW-203S, OW-19, OW-42, OW-43
	Deep Overburden	MW-201D, MW-202D, MW-203D, OW-18, OW-38, OW-41
	Bedrock	MW-201B, MW-202B, MW-203B, OW-17, OW-37
Asbestos Lagoons	Shallow Overburden	MW-208S, OW-11, OW-12, OW-14, OW-21
	Deep Overburden	MW-208D, OW-10, OW-13, OW-20
	Bedrock	MW-208B, MW-209B, OW-09

TABLE 6-5. SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Background							
Volatile Organics (µg/kg)							
Methylene Chloride	3 / 3	3	17.3	NU	7.0 - 36	85,000	No
Pesticides and PCBs (µg/kg)							
alpha-Chlordane	1 / 3	3	0.707	1.8 - 1.9	0.27	490 (5)	No
4,4'-DDD	3 / 3	3	2.03	NU	1.3 - 2.6	2,700	No
4,4'-DDE	3 / 3	3	2.97	NU	1.6 - 4.9	1,900	No
4,4'-DDT	3 / 3	3	5.47	NU	2.9 - 7.7	1,900	No
Dieldrin	1 / 3	3	1.92	3.5 - 3.8	2.1	40	No
Endosulfan II	2 / 3	3	1.18	3.9	0.60 - 1.0	47,000 NC (6)	No
Heptachlor Epoxide	2 / 3	3	1.19	1.9	0.62 - 2.0	70	No
Methoxychlor	1 / 3	3	6.93	18 - 20	1.8	39,000 NC	No
Inorganics (mg/kg)							
Aluminum	3 / 3	3	7,880	NU	5,350 - 9,630	NA (7)	NA
Arsenic	3 / 3	3	5.70	NU	4.0 - 7.6	0.43 (8)	**Yes**
Barium	3 / 3	3	18.3	NU	9.3 - 32.0	550 NC	No
Calcium	1 / 3	3	362	89.8 - 186	949	NA	NA
Copper	3 / 3	3	6.23	NU	4.7 - 8.9	310 NC	No
Iron	3 / 3	3	6,670	NU	4,640 - 8,350	NA (7)	NA
Lead	1 / 3	3	34.8	2.4 - 2.5	102	400 (9)	No
Magnesium	3 / 3	3	974	NU	687 - 1,480	NA	NA
Manganese	3 / 3	3	142	NU	32 - 206	187 NC	**Yes**
Vanadium	3 / 3	3	11.3	NU	7.2 - 14	55 NC	No
Zinc	2 / 3	3	23.9	13.2	18 - 47	2,300 NC	No
B&M Railroad Landfill							
Volatile Organics (µg/kg)							
Acetone	5 / 14	14	14.7	10 - 79	7.0 - 42	780,000 NC	No
2-Butanone	1 / 14	14	5.54	10 - 12	7.0	4,700,000 NC	No
Methylene Chloride	8 / 14	14	93.6	10 - 53	21 - 280	85,000	No
Semivolatile Organics (µg/kg)							
Acenaphthene	5 / 14	14	1,660	340 - 11,000	96 - 340	470,000 NC	No
Acenaphthylene	11 / 14	14	1,670	350 - 11,000	230 - 3,200	230,000 NC (10)	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Anthracene	12 / 14	14	1,920	10,000 - 11,000	140 - 5,800	2,300,000 NC	No
Benzo(a)anthracene	14 / 14	14	3,540	NU	260 - 16,000	880	**Yes**
Benzo(a)pyrene	14 / 14	14	3,590	NU	200 - 18,000	88	**Yes**
Benzo(b)fluoranthene	14 / 14	14	8,210	NU	520 - 33,000	880	**Yes**
Benzo(g,h,i)perylene	12 / 14	14	1,940	340 - 10,000	110 - 10,000	230,000 NC (10)	No
Bis(2-chloroethyl) ether	1 / 14	14	1,670	340 - 11,000	280	580	No
Bis(2-ethylhexyl)phthalate	7 / 14	14	3,660	350 - 11,000	36 - 25,000	46,000	No
Butylbenzylphthalate	5 / 14	14	2,940	340 - 11,000	1,400 - 10,000	1,600,000 NC	No
Carbazole	8 / 14	14	1,530	340 - 11,000	90 - 3,400	32,000	No
Chrysene	14 / 14	14	4,020	NU	380 - 20,000	88,000	No
Di-n-butylphthalate	1 / 14	14	1,680	340 - 11,000	390	780,000 NC	No
Dibenzo(a,h)anthracene	7 / 14	14	1,610	340 - 11,000	90 - 4,200	88	**Yes**
Dibenzofuran	5 / 14	14	1,680	340 - 11,000	130 - 290	31,000 NC	No
Fluoranthene	14 / 14	14	6,050	NU	460 - 28,000	310,000 NC	No
Fluorene	5 / 14	14	1,670	340 - 11,000	97 - 340	310,000 NC	No
Indeno(1,2,3-cd)pyrene	13 / 14	14	2,030	10,000	110 - 10,000	880	**Yes**
Isophorone	1 / 14	14	1,680	340 - 11,000	430	670,000	No
2-Methylnaphthalene	7 / 14	14	1,670	340 - 11,000	130 - 260	230,000 NC (10)	No
4-Methylphenol	2 / 14	14	1,650	340 - 11,000	90 - 96	39,000 NC	No
Naphthalene	6 / 14	14	1,680	340 - 11,000	100 - 280	310,000 NC	No
Phenanthrene	14 / 14	14	2,510	NU	240 - 17,000	230,000 NC (10)	No
Phenol	3 / 14	14	1,660	340 - 11,000	110 - 200	4,700,000 NC	No
Pyrene	14 / 14	14	6,250	NU	410 - 24,000	230,000 NC	No
Pesticides and PCBs (μg/kg)							
Aldrin	7 / 14	14	1.57	1.8 - 1.9	0.98 - 3.9	38	No
alpha-BHC	5 / 13	13	1.31	1.8 - 2.1	1.1 - 2.5	100	No
beta-BHC	1 / 14	14	0.950	1.8 - 2.1	1.1	350	No
delta-BHC	2 / 13	13	0.988	1.8 - 2.1	1.1 - 1.4	100 (11)	No
gamma-BHC(Lindane)	8 / 14	14	0.820	1.8 - 2.1	0.18 - 1.8	490	No
alpha-Chlordane	6 / 13	13	4.42	1.8 - 2.1	2.7 - 13	490 (5)	No
gamma-Chlordane	5 / 13	13	2.52	1.8 - 2.1	3.4 - 7.5	490 (5)	No
4,4'-DDD	14 / 14	14	28.2	NU	5.9 - 97	2,700	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
4,4'-DDE	10 / 14	14	14.3	3.4 - 3.7	5.2 - 50	1,900	No
4,4'-DDT	13 / 14	14	62.1	50	11 - 230	1,900	No
Dieldrin	1 / 13	13	3.09	3.4 - 30	5.2	40	No
Endosulfan I	2 / 13	13	0.996	1.8 - 2.1	0.85 - 1.9	47,000 NC	No
Endosulfan II	5 / 13	13	6.23	3.4 - 4.1	3.4 - 23	47,000 NC (6)	No
Endosulfan Sulfate	7 / 13	13	19.9	3.4 - 4.1	5.8 - 79	47,000 NC (6)	No
Endrin	11 / 13	13	55.6	3.4	3.0 - 140	2,300 NC	No
Endrin Aldehyde	7 / 13	13	29.1	3.4 - 4.1	8.3 - 110	2,300 NC (12)	No
Endrin Ketone	9 / 13	13	55.9	3.4 - 3.7	5.1 - 170	2,300 NC (12)	No
Heptachlor	3 / 13	13	0.835	1.8 - 2.1	0.46 - 0.59	140	No
Heptachlor Epoxide	14 / 14	14	3.93	NU	0.69 - 9.7	70	No
Methoxychlor	10 / 13	13	66.0	18	22 - 170	39,000 NC	No
Inorganics (mg/kg)							
Aluminum	14 / 14	14	5,420	NU	4,370 - 7,260	NA (7)	NA
Antimony	1 / 14	14	16.9	7.20 - 25.4	155	3.1 NC	**Yes**
Arsenic	14 / 14	14	18.7	NU	7.50 - 36.0	0.43 (8)	**Yes**
Barium	14 / 14	14	258	NU	26.9 - 922	550 NC	**Yes**
Cadmium	8 / 14	14	7.59	0.60 - 1.6	2.10 - 34.8	3.9 NC	**Yes**
Calcium	14 / 14	14	3,290	NU	503 - 14,700	NA	NA
Chromium	13 / 14	14	73.9	11.3	13.7 - 304	39 NC (13)	**Yes**
Cobalt	13 / 14	14	9.96	2.90	3.40 - 26.0	470 NC	No
Copper	14 / 14	14	361	NU	50.4 - 1,030	310 NC	**Yes**
Cyanide	10 / 14	14	3.76	0.50 - 0.65	0.630 - 39.0	160 NC (14)	No
Iron	14 / 14	14	35,300	NU	8,990 - 76,800	NA (7)	NA
Lead	14 / 14	14	559	NU	110 - 1,130	400 (9)	**Yes**
Magnesium	14 / 14	14	1,930	NU	1,140 - 4,300	NA	NA
Manganese	14 / 14	14	396	NU	135 - 1,080	187 NC	**Yes**
Mercury	12 / 14	14	1.07	0.10 - 0.11	0.260 - 3.40	2.3 NC (15)	**Yes**
Nickel	9 / 14	14	60.1	10 - 12.7	23.5 - 154	160 NC	No
Potassium	8 / 14	14	463	477 - 592	472 - 792	NA	NA
Selenium	4 / 14	14	0.741	0.60 - 0.70	0.780 - 3.10	39 NC	No
Silver	1 / 9	9	0.522	0.80 - 1.0	1.20	39 NC	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Vanadium	14 / 14	14	17.5	NU	8.70 - 34.8	55 NC	No
Zinc	14 / 14	14	1,240	NU	53.5 - 4,400	2,300 NC	**Yes**
RSI Landfill							
Volatile Organics (μg/kg)							
Methylene Chloride	2 / 6	6	116	10 - 1,200	14 - 64	85,000	No
Semivolatile Organics (μg/kg)							
Benzo(a)anthracene	1 / 6	6	162	340	120	880	No
Benzo(b)fluoranthene	3 / 6	6	205	340	150 - 380	880	No
Chrysene	2 / 6	6	188	340	110 - 340	88,000	No
Fluoranthene	3 / 6	6	190	340	120 - 390	310,000 NC	No
Phenol	2 / 6	6	168	340	110 - 220	4,700,000 NC	No
Pyrene	3 / 6	6	188	340	130 - 330	230,000 NC	No
Pesticides and PCBs (μg/kg)							
gamma-Chlordane	1 / 6	6	0.805	1.8	0.33	490 (5)	No
4,4'-DDD	5 / 6	6	0.948	3.4	0.25 - 1.6	2,700	No
4,4'-DDE	5 / 6	6	1.02	3.4	0.60 - 1.4	1,900	No
4,4'-DDT	6 / 6	6	2.53	NU	0.40 - 5.2	1,900	No
Endosulfan II	1 / 6	6	1.50	3.4	0.51	47,000 NC (6)	No
Endrin	4 / 6	6	1.01	3.4	0.38 - 1.4	2,300 NC	No
Endrin Ketone	3 / 6	6	1.21	3.4	0.46 - 0.87	2,300 NC (12)	No
Heptachlor Epoxide	2 / 6	6	0.808	1.8	0.50 - 0.75	70	No
Methoxychlor	3 / 6	6	5.68	18	0.70 - 4.0	39,000 NC	No
Inorganics (mg/kg)							
Aluminum	6 / 6	6	7,180	NU	6,120 - 9,470	NA (7)	NA
Arsenic	6 / 6	6	4.45	NU	3.90 - 4.80	0.43 (8)	**Yes**
Barium	6 / 6	6	29.8	NU	15.2 - 46.0	550 NC	No
Calcium	6 / 6	6	794	NU	313 - 1,180	NA	NA
Chromium	4 / 6	6	13.9	8.6 - 9.5	15.7 - 23.7	39 NC (13)	No
Cobalt	6 / 6	6	3.93	NU	2.18 - 6.50	470 NC	No
Copper	5 / 6	6	11.6	6.5	10.7 - 19.7	310 NC	No
Iron	6 / 6	6	9,710	NU	6,810 - 13,600	NA (7)	NA
Lead	6 / 6	6	58.8	NU	4.0 - 248	400 (9)	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Magnesium	6 / 6	6	2,560	NU	1,360 - 3,780	NA	NA
Manganese	6 / 6	6	161	NU	131 - 212	187 NC	**Yes**
Potassium	5 / 6	6	1,370	484	689 - 1,990	NA	NA
Vanadium	6 / 6	6	15.3	NU	9.40 - 20.2	55 NC	No
Zinc	6 / 6	6	34.2	NU	20.4 - 59.0	2,300 NC	No
B&M Locomotive Shop Disposal Area							
Volatile Organics (μg/kg)							
Methylene Chloride	2 / 5	5	9.90	10 - 11	13 - 21	85,000	No
Semivolatile Organics (μg/kg)							
Acenaphthene	1 / 5	5	304	340 - 400	790	470,000 NC	No
Acenaphthylene	1 / 5	5	146	340 - 400	20	230,000 NC (10)	No
Anthracene	2 / 5	5	413	340 - 400	25 - 1,500	2,300,000 NC	No
Benzo(a)anthracene	4 / 5	5	666	340	140 - 2,300	880	**Yes**
Benzo(a)pyrene	4 / 5	5	503	340	65 - 1,700	88	**Yes**
Benzo(b)fluoranthene	4 / 5	5	890	340	140 - 2,900	880	**Yes**
Benzo(g,h,i)perylene	3 / 5	5	330	340 - 380	130 - 960	230,000 NC (10)	No
Benzo(k)fluoranthene	1 / 5	5	164	340 - 400	110	8,800	No
Bis(2-ethylhexyl)phthalate	1 / 5	5	166	340 - 400	120	46,000	No
Carbazole	1 / 5	5	322	340 - 400	880	32,000	No
Chrysene	4 / 5	5	707	340	150 - 2,400	88,000	No
Dibenzo(a,h)anthracene	1 / 5	5	226	340 - 400	400	88	**Yes**
Dibenzofuran	1 / 5	5	294	340 - 400	740	31,000 NC	No
Fluoranthene	5 / 5	5	1,160	NU	140 - 4,200	310,000 NC	No
Fluorene	1 / 5	5	298	340 - 400	760	310,000 NC	No
Indeno(1,2,3-cd)pyrene	3 / 5	5	314	340 - 380	110 - 920	880	**Yes**
2-Methylnaphthalene	2 / 5	5	224	340 - 380	220 - 370	230,000 NC (10)	No
Naphthalene	2 / 5	5	200	340 - 380	180 - 290	310,000 NC	No
Phenanthrene	5 / 5	5	1,380	NU	100 - 5,900	230,000 NC (10)	No
Pyrene	5 / 5	5	1,300	NU	170 - 4,800	230,000 NC	No
Pesticides and PCBs (μg/kg)							
Aldrin	3 / 5	5	1.43	1.8 - 1.9	0.50 - 2.8	38	No
Aroclor-1016	1 / 5	5	14.5	34 - 39	2.2	83 (16)	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
beta-BHC	1 / 5	5	0.942	1.8 - 2.0	0.96	350	No
alpha-Chlordane	3 / 5	5	0.764	1.8 - 1.9	0.41 - 1.0	490 (5)	No
gamma-Chlordane	3 / 5	5	1.69	1.8 - 1.9	0.62 - 4.0	490 (5)	No
4,4'-DDD	4 / 5	5	2.17	3.8	0.18 - 5.0	2,700	No
4,4'-DDE	3 / 5	5	1.72	3.4 - 3.8	1.1 - 2.4	1,900	No
4,4'-DDT	4 / 5	5	4.47	3.8	0.48 - 9.3	1,900	No
Dieldrin	1 / 5	5	1.74	3.4 - 3.8	1.7	40	No
Endosulfan II	3 / 5	5	1.59	3.4 - 3.8	1.2 - 2.0	47,000 NC (6)	No
Endrin	5 / 5	5	1.82	NU	0.20 - 3.5	2,300 NC	No
Endrin Ketone	1 / 5	5	2.57	3.4 - 3.9	5.6	2,300 NC (12)	No
Heptachlor Epoxide	3 / 5	5	1.15	1.8 - 1.9	0.69 - 1.8	70	No
Methoxychlor	2 / 5	5	9.48	18 - 19	0.89 - 19	39,000 NC	No
Inorganics (mg/kg)							
Aluminum	5 / 5	5	5,330	NU	4,350 - 7,660	NA (7)	NA
Antimony	2 / 5	5	14.2	9.3	4.10 - 53.0	3.1 NC	**Yes**
Arsenic	5 / 5	5	17.3	NU	4.50 - 49.3	0.43 (8)	**Yes**
Barium	5 / 5	5	99.1	NU	22.2 - 342	550 NC	No
Beryllium	1 / 5	5	0.442	0.32 - 0.80	0.850	0.15	**Yes**
Cadmium	1 / 5	5	0.540	0.40 - 1.0	1.0	3.9 NC	No
Calcium	5 / 5	5	2,200	NU	570 - 6,090	NA	NA
Chromium	4 / 5	5	31.1	11.6	20.4 - 87.4	39 NC (13)	**Yes**
Cobalt	4 / 5	5	5.93	2.3	3.90 - 13.9	470 NC	No
Copper	5 / 5	5	734	NU	12.7 - 3,140	310 NC	**Yes**
Cyanide	2 / 5	5	0.515	0.50	0.890 - 0.935	160 NC (14)	No
Iron	5 / 5	5	34,800	NU	7,020 - 101,000	NA (7)	NA
Lead	4 / 5	5	575	5.2	13.2 - 2,370	400 (9)	**Yes**
Magnesium	5 / 5	5	2,550	NU	1,370 - 4,230	NA	NA
Manganese	5 / 5	5	322	NU	99.4 - 917	187 NC	**Yes**
Mercury	1 / 5	5	0.103	0.050 - 0.20	0.190	2.3 NC (15)	No
Nickel	3 / 5	5	18.2	8.8 - 13.3	14.3 - 46.5	160 NC	No
Potassium	3 / 5	5	658	472 - 474	424 - 1,660	NA	NA
Selenium	2 / 5	5	1.46	0.60 - 0.65	0.880 - 5.50	39 NC	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Sodium	1 / 5	5	2,640	62.9 - 143	13,000	NA	NA
Thallium	1 / 5	5	0.362	0.60 - 0.68	0.570	0.63 NC (17)	No
Vanadium	5 / 5	5	12.5	NU	7.60 - 17.9	55 NC	No
Zinc	5 / 5	5	222	NU	28.1 - 821	2,300 NC	No
<u>Old B&M Oil/Sludge Recycling Area</u>							
Volatile Organics (μg/kg)							
Carbon Disulfide	1 / 6	6	4.58	10 - 11	2.0	780,000 NC	No
Semivolatile Organics (μg/kg)							
Anthracene	1 / 6	6	173	330 - 680	19	2,300,000 NC	No
Benzo(a)anthracene	3 / 6	6	155	330 - 680	39 - 140	880	No
Benzo(a)pyrene	3 / 6	6	146	330 - 680	51 - 80	88	No
Benzo(b)fluoranthene	3 / 6	6	168	330 - 680	61 - 200	880	No
Benzo(g,h,i)perylene	1 / 6	6	183	330 - 680	80	230,000 NC (10)	No
Benzo(k)fluoranthene	3 / 6	6	145	330 - 680	39 - 110	8,800	No
Carbazole	1 / 6	6	176	330 - 680	33	32,000	No
Chrysene	3 / 6	6	179	330 - 680	79 - 200	88,000	No
Dibenzofuran	1 / 6	6	174	330 - 680	22	31,000 NC	No
Fluoranthene	3 / 6	6	211	330 - 680	71 - 400	310,000 NC	No
Indeno(1,2,3-cd)pyrene	1 / 6	6	180	330 - 680	55	880	No
2-Methylnaphthalene	1 / 6	6	183	330 - 680	77	230,000 NC (10)	No
Naphthalene	1 / 6	6	177	330 - 680	43	310,000 NC	No
Phenanthrene	2 / 6	6	195	330 - 680	140 - 180	230,000 NC (10)	No
Pyrene	3 / 6	6	199	330 - 680	56 - 300	230,000 NC	No
Pesticides and PCBs (μg/kg)							
alpha-Chlordane	1 / 6	6	1.61	1.7 - 1.8	5.2	490 (5)	No
gamma-Chlordane	1 / 6	6	1.59	1.7 - 1.8	5.1	490 (5)	No
4,4'-DDD	1 / 6	6	4.09	3.3 - 3.5	16	2,700	No
4,4'-DDE	1 / 6	6	3.43	3.3 - 3.5	12	1,900	No
4,4'-DDT	1 / 6	6	2.23	3.3 - 6.8	3.1	1,900	No
Endosulfan I	1 / 6	6	2.14	1.7 - 1.8	8.4	47,000 NC	No
Endosulfan II	1 / 6	6	2.68	3.3 - 3.5	7.5	47,000 NC (6)	No
Endrin	2 / 6	6	3.11	3.3 - 3.5	2.0 - 9.8	2,300 NC	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Endrin Ketone	2 / 6	6	2.59	3.3 - 3.5	2.8 - 5.9	2,300 NC (12)	No
Inorganics (mg/kg)							
Aluminum	6 / 6	6	6,300	NU	4,130 - 8,640	NA (7)	NA
Antimony	1 / 6	6	3.64	3.0 - 3.3	14.1	3.1 NC	**Yes**
Arsenic	6 / 6	6	8.80	NU	6.60 - 10.8	0.43 (8)	**Yes**
Barium	6 / 6	6	25.0	NU	14.1 - 38.7	550 NC	No
Beryllium	1 / 6	6	0.128	0.20	0.270	0.15	**Yes**
Calcium	6 / 6	6	995	NU	616 - 1,530	NA	NA
Chromium	4 / 6	6	13.6	12.7 - 13.2	15.6 - 18.1	39 NC (13)	No
Cobalt	5 / 6	6	3.74	2.9	3.30 - 4.80	470 NC	No
Copper	6 / 6	6	18.0	NU	7.0 - 41.1	310 NC	No
Iron	6 / 6	6	9,320	NU	7,550 - 10,600	NA (7)	NA
Lead	6 / 6	6	82.6	NU	10.8 - 362	400 (9)	No
Magnesium	6 / 6	6	2,410	NU	1,950 - 2,940	NA	NA
Manganese	6 / 6	6	110	NU	88.1 - 135	187 NC	No
Potassium	6 / 6	6	933	NU	678 - 1,190	NA	NA
Selenium	1 / 6	6	0.274	0.44 - 0.48	0.500	39 NC	No
Vanadium	6 / 6	6	15.4	NU	11.7 - 18.7	55 NC	No
Zinc	6 / 6	6	51.0	NU	23.7 - 133	2,300 NC	No
<u>Contaminated Soil Area</u>							
Volatile Organics (μg/kg)							
Acetone	10 / 46	46	18.0	11 - 120	6.0 - 62	780,000 NC	No
Chloroethane	4 / 46	46	9.78	10 - 12	23 - 79	3,100,000 NC	No
Methylene Chloride	34 / 46	46	79.3	11 - 62	6.0 - 450	85,000	No
Semivolatile Organics (μg/kg)							
Acenaphthene	3 / 45	45	1,410	340 - 11,000	100 - 8,000	470,000 NC	No
Acenaphthylene	21 / 46	46	1,370	350 - 12,000	78 - 540	230,000 NC (10)	No
Anthracene	25 / 46	46	1,350	350 - 11,000	130 - 12,000	2,300,000 NC	No
Benzo(a)anthracene	32 / 45	45	1,700	350 - 11,000	140 - 18,000	880	**Yes**
Benzo(a)pyrene	32 / 45	45	1,640	350 - 11,000	110 - 15,000	88	**Yes**
Benzo(b)fluoranthene	39 / 45	45	2,560	350 - 11,000	130 - 28,000	880	**Yes**
Benzo(g,h,i)perylene	25 / 45	45	1,450	340 - 11,000	100 - 7,400	230,000 NC (10)	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Bis(2-ethylhexyl)phthalate	13 / 44	44	1,410	350 - 12,000	120 - 4,200	46,000	No
Carbazole	15 / 46	46	1,400	350 - 11,000	87 - 8,900	32,000	No
Chrysene	36 / 45	45	1,780	350 - 11,000	120 - 20,000	88,000	No
Di-n-butylphthalate	1 / 45	45	1,530	340 - 12,000	7,600	780,000 NC	No
Dibenzo(a,h)anthracene	11 / 45	45	1,300	340 - 11,000	94 - 3,300	88	**Yes**
Dibenzofuran	17 / 46	46	1,420	350 - 11,000	56 - 10,000	31,000 NC	No
2,4-Dimethylphenol	1 / 45	45	1360	340 - 12000	130	160,000 NC	No
Fluoranthene	42 / 46	46	2,520	350 - 11,000	140 - 40,000	310,000 NC	No
Fluorene	5 / 46	46	1,380	340 - 11,000	95 - 8,100	310,000 NC	No
Indeno(1,2,3-cd)pyrene	30 / 45	45	1,360	350 - 11,000	87 - 7,900	880	**Yes**
2-Methylnaphthalene	32 / 46	46	1,270	350 - 11,000	98 - 5,200	230,000 NC (10)	No
2-Methylphenol	1 / 45	45	1,360	340 - 12,000	150	390,000 NC	No
4-Methylphenol	1 / 45	45	1,370	340 - 12,000	280	39,000 NC	No
Naphthalene	28 / 46	46	1,300	350 - 11,000	97 - 8,500	310,000 NC	No
Pentachlorophenol	9 / 46	46	4,480	830 - 30,000	140 - 75,000	5,300	**Yes**
Phenanthrene	39 / 46	46	2,250	350 - 11,000	99 - 48,000	230,000 NC (10)	No
Phenol	2 / 45	45	1,370	340 - 12,000	220 - 230	4,700,000 NC	No
Pyrene	42 / 45	45	2,320	350 - 11,000	110 - 32,000	230,000 NC	No
Pesticides and PCBs (μg/kg)							
Aldrin	42 / 46	46	2.22	1.8 - 1.9	0.23 - 8.1	38	No
alpha-BHC	17 / 44	44	0.931	1.8 - 2.0	0.37 - 1.8	100	No
beta-BHC	6 / 43	43	0.963	1.8 - 2.0	0.34 - 2.4	350	No
gamma-BHC(Lindane)	11 / 44	44	0.986	1.8 - 2.0	0.21 - 5.3	490	No
alpha-Chlordane	17 / 44	44	1.20	1.8 - 2.0	0.49 - 8.3	490 (5)	No
gamma-Chlordane	35 / 46	46	3.12	1.8 - 2.0	0.41 - 11.0	490 (5)	No
4,4'-DDD	46 / 46	46	14.3	NU	1.1 - 150	2,700	No
4,4'-DDE	41 / 45	45	8.08	3.5 - 3.9	1.7 - 22	1,900	No
4,4'-DDT	44 / 46	46	372	3.5 - 3.6	4.4 - 16,000	1,900	**Yes**
Dieldrin	10 / 43	43	2.86	3.5 - 3.9	2.5 - 17	40	No
Endosulfan I	4 / 43	43	1.95	1.8 - 2.0	3.7 - 32	47,000 NC	No
Endosulfan II	20 / 43	43	1.89	3.5 - 3.9	0.40 - 4.2	47,000 NC (6)	No
Endosulfan Sulfate	20 / 44	44	7.29	3.4 - 3.9	2.2 - 75	47,000 NC (6)	No

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Endrin	30 / 44	44	4.02	3.4 - 3.9	0.38 - 12	2,300 NC	No
Endrin Aldehyde	12 / 43	43	2.67	3.4 - 3.9	2.5 - 15	2,300 NC (12)	No
Endrin Ketone	31 / 44	44	7.90	3.5 - 3.9	0.86 - 63	2,300 NC (12)	No
Heptachlor	3 / 43	43	0.893	1.8 - 2.0	0.24 - 0.54	140	No
Heptachlor Epoxide	21 / 44	44	1.36	1.8 - 2.0	0.74 - 7.8	70	No
Methoxychlor	17 / 45	45	18.9	18 - 20	11 - 76	39,000 NC	No
Inorganics (mg/kg)							
Antimony	15 / 46	46	28.2	7.6 - 33.7	7.98 - 494	3.1 NC	**Yes**
Arsenic	46 / 46	46	25.8	NU	5.80 - 233	0.43 (8)	**Yes**
Barium	46 / 46	46	226	NU	19.6 - 3,630	550 NC	**Yes**
Cadmium	9 / 46	46	1.17	0.60 - 2.2	1.10 - 8.00	3.9 NC	**Yes**
Calcium	44 / 46	46	2,120	287 - 379	510 - 9,730	NA	NA
Chromium	44 / 46	46	42.8	12.4 - 12.6	13.3 - 385	39 NC (13)	**Yes**
Cobalt	45 / 46	46	6.93	2.5	3.20 - 15.2	470 NC	No
Copper	45 / 46	46	1,510	89.2	35.6 - 46,200	310 NC	**Yes**
Cyanide	6 / 46	46	0.332	0.50 - 0.62	0.570 - 0.810	160 NC (14)	No
Iron	46 / 46	46	37,400	NU	11,800 - 146,000	NA (7)	NA
Lead	46 / 46	46	1,310	NU	69.1 - 10,800	400 (9)	**Yes**
Magnesium	46 / 46	46	2,560	NU	682 - 6,630	NA	NA
Manganese	46 / 46	46	425	NU	105 - 3,400	187 NC	**Yes**
Mercury	28 / 46	46	0.432	0.11 - 0.22	0.120 - 2.50	2.3 (15)	**Yes**
Nickel	34 / 46	46	32.4	7.5 - 14	12.4 - 329	160 NC	**Yes**
Potassium	19 / 46	46	616	487 - 3,830	309 - 2,460	NA	NA
Selenium	17 / 46	46	0.720	0.60 - 1.4	0.700 - 3.90	39 NC	No
Silver	1 / 35	35	0.755	0.86 - 0.99	11.1	39 NC	No
Vanadium	46 / 46	46	16.8	NU	6.60 - 48.8	55 NC	No
Zinc	46 / 46	46	443	NU	29.4 - 4,170	2,300 NC	**Yes**

NOTES:

1. The number of samples in which the contaminant was detected divided by the total number of samples analyzed, excluding rejected samples, from sampling in July, August and September, 1993.
2. The number of samples used in calculating the mean.

TABLE 6-5(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

NOTES (continued):

3. The arithmetic mean was calculated using the detected concentrations and one-half the detection limit for non-detect samples. In some cases, high detection limits resulted in the calculation of arithmetic means above maximum detected concentrations.
4. EPA, Region III residential soil RBCs were used. RBCs for noncarcinogenic chemicals, indicated by NC, are based on a hazard quotient of 0.1, following EPA Region I guidance. Therefore, the soil RBCs reported by Region III were divided by 10 for these noncarcinogenic chemicals.
5. The RBC for chlordane was used.
6. The RBC for endosulfan I was used.
7. The RBCs for aluminum and iron are based on provisional toxicity criteria and were not used since Region I does not concur with the use of these values in a risk assessment.
8. The RBC for arsenic as a carcinogen was used.
9. Because no RBC exists for lead, a residential soil screening level for lead of 400 mg/kg (U.S. EPA, 1994d) was used.
10. The RBC for pyrene was used for noncarcinogenic PAHs that lack RBCs.
11. The RBC for alpha-BHC was used.
12. The RBC for endrin was used.
13. The RBC for chromium VI was used.
14. The RBC for free cyanide was used.
15. The RBC for inorganic mercury was used.
16. The RBC for carcinogenic PCBs was used.
17. The RBC for thallium carbonate, thallium chloride or thallium sulfate was used.

NU = Not used; chemical was detected in all samples.
PCBs = Polychlorinated Biphenyls, or Aroclors.
RBC = Risk-based concentration.
NC = Noncarcinogenic Chemicals
NA = Not applicable. RBCs were not available for calcium, magnesium, potassium, and sodium, which are essential human nutrients. Detected concentrations of nutrients were compared to allowable daily intake (ADI) levels.
Yes = The maximum detected concentration of this chemical was detected above the residential soil RBC, therefore the chemical was selected as a chemical of potential concern (COPC). COPCs were not selected in background data.
No = This chemical was detected below residential soil RBCs, therefore the chemical was eliminated as a chemical of potential concern.

TABLE 6-6. SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Background							
Volatile Organics (µg/kg)							
2-Butanone	1 / 3	3	46.5	16 - 23	120	4,700,000 NC	No
2-Hexanone	1 / 3	3	16.8	16 - 23	31	NA	(16)
Semivolatile Organics (µg/kg)							
Benzo(a)anthracene	1 / 3	3	326	770 - 1,100	42	880	No
Benzo(a)pyrene	2 / 4	4	315	770 - 1,100	34 - 290	88	**Yes**
Benzo(b)fluoranthene	2 / 3	3	244	1,100	72 - 110	880	No
Benzo(g,h,i)perylene	1 / 3	3	328	770 - 1,100	48	230,000 NC (5)	No
Bis(2-ethylhexyl)phthalate	1 / 3	3	358	770 - 1,100	140	46,000	No
Chrysene	2 / 3	3	216	1,100	39 - 58	88,000	No
Fluoranthene	2 / 3	3	234	1,100	67 - 85	310,000 NC	No
Indeno(1,2,3-cd)pyrene	1 / 3	3	325	770 - 1,100	40	880	No
Phenanthrene	2 / 3	3	220	1,100	46 - 65	230,000 NC (5)	No
Pyrene	3 / 3	3	110	NU	91 - 130	230,000 NC	No
Pesticides and PCBs (µg/kg)							
PCBs	2 / 3	3	31.9	100	9.6 - 36	83 (8)	No
beta-BHC	1 / 3	3	1.53	2.8 - 5.4	0.48	350	No
delta-BHC	2 / 3	3	1.04	5.4	0.19 - 0.24	100 (7)	No
alpha-Chlordane	1 / 3	3	1.90	2.8 - 5.4	1.6	490 (6)	No
gamma-Chlordane	1 / 3	3	1.97	2.8 - 5.4	1.8	490 (6)	No
4,4'-DDD	2 / 3	3	9.33	10	11 - 12	2,700	No
4,4'-DDE	2 / 3	3	6.07	10	3.2 - 10	1,900	No
4,4'-DDT	1 / 3	3	3.18	7.8 - 10	0.64	1,900	No
Dieldrin	2 / 3	3	1.99	10	0.11 - 0.87	40	No
Endosulfan I	1 / 3	3	1.92	3.9 - 5.4	1.1	47,000 NC	No
Inorganics (mg/kg)							
Aluminum	4 / 4	4	8,130	NU	2,130 - 14,800	NA (9)	NA
Arsenic	2 / 3	3	4.0	3.6	5.0 - 5.20	0.43 (10)	**Yes**
Barium	4 / 4	4	38.8	NU	26.1 - 59.1	550 NC	No
Beryllium	2 / 3	3	1.47	0.82	1.30 - 2.70	0.15	**Yes**
Calcium	4 / 4	4	3,740	NU	1,490 - 6,070	NA	NA

TABLE 6-6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Chromium	2 / 3	3	11.9	10.2	14.2 - 16.4	39 NC (11)	No
Cobalt	2 / 3	3	4.30	3.8	4.80 - 6.20	470 NC	No
Copper	3 / 4	4	13.8	9.7	12.8 - 20.6	310 NC	No
Iron	4 / 4	4	4,820	NU	1,340 - 6,590	NA (9)	NA
Lead	4 / 4	4	24.8	NU	17.4 - 43.0	400 (12)	No
Magnesium	4 / 4	4	1,230	NU	500 - 1,760	NA	NA
Manganese	4 / 4	4	247	NU	32.7 - 469	187 NC	**Yes**
Mercury	2 / 3	3	0.168	0.11	0.160 - 0.290	2.3 NC (13)	No
Potassium	3 / 3	3	579	NU	323 - 1,040	NA	NA
Vanadium	4 / 4	4	10.6	NU	7.20 - 14.4	55 NC	No
Zinc	4 / 4	4	34.9	NU	26.30 - 46.4	2,300 NC	No
<u>West Middlesex Canal Area</u>							
Volatile Organics (μg/kg)							
2-Butanone	1 / 13	13	10.7	13 - 30	22	4,700,000 NC	No
Toluene	1 / 13	13	10.2	13 - 30	18	1,600,000 NC	No
Xylenes (total)	1 / 13	13	18.2	13 - 30	120	16,000,000 NC	No
Semivolatile Organics (μg/kg)							
Benzo(a)anthracene	4 / 13	13	4,080	450 - 26,000	66 - 2,600	880	**Yes**
Benzo(a)pyrene	1 / 13	13	4,890	450 - 26,000	70	88	No
Benzo(b)fluoranthene	6 / 14	14	3,870	460 - 26,000	35 - 3,600	880	**Yes**
Benzo(k)fluoranthene	1 / 13	13	4,170	450 - 26,000	3,000	8,800	No
Bis(2-ethylhexyl)phthalate	6 / 13	13	4,120	620 - 26,000	62 - 7,400	46,000	No
Butylbenzylphthalate	1 / 14	14	4,580	450 - 26,000	350	1,600,000 NC	No
Chrysene	7 / 15	15	3,610	460 - 26,000	23 - 3,600	88,000	No
Fluoranthene	8 / 15	15	3,740	460 - 26,000	41 - 5,400	310,000 NC	No
2-Methylnaphthalene	1 / 13	13	4,020	450 - 25,000	1,500	230,000 NC (5)	No
Phenanthrene	6 / 14	14	3,740	460 - 26,000	25 - 2,000	230,000 NC (5)	No
Pyrene	8 / 15	15	4,230	460 - 26,000	47 - 620	230,000 NC	No
Pesticides and PCBs (μg/kg)							
PCBs	9 / 15	15	256	45 - 85	13 - 2,000	83 (8)	**Yes**
alpha-BHC	2 / 13	13	1.47	2.3 - 5.1	0.40 - 0.46	100	No
delta-BHC	1 / 13	13	1.58	2.3 - 5.1	0.32	100 (7)	No

TABLE 6-6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
alpha-Chlordane	3 / 14	14	3.61	2.3 - 5.1	1.2 - 18	490 (6)	No
gamma-Chlordane	2 / 13	13	2.91	2.3 - 5.1	1.4 - 18	490 (6)	No
4,4'-DDD	7 / 14	14	7.15	4.5 - 8.5	0.64 - 34	2,700	No
4,4'-DDE	8 / 13	13	4.14	4.5 - 8.5	0.09 - 18	1,900	No
Dieldrin	7 / 13	13	2.61	4.5 - 8.5	0.14 - 10	40	No
Endosulfan I	5 / 13	13	1.31	2.3 - 5.1	0.21 - 2.0	47,000 NC	No
Endosulfan II	3 / 13	13	2.81	4.5 - 10	0.72 - 2.0	47,000 NC (14)	No
Endrin	5 / 13	13	2.84	3.8 - 8.3	0.26 - 5.3	2,300 NC	No
Heptachlor Epoxide	3 / 13	13	1.75	2.3 - 5.1	1.0 - 3.1	70	No
Methoxychlor	4 / 13	13	12.9	23 - 51	3.3 - 7.6	39,000 NC	No
Inorganics (mg/kg)							
Aluminum	15 / 15	15	8,150	NU	2,520 - 29,400	NA (9)	NA
Arsenic	13 / 15	15	16.4	3.9 - 6.0	1.55 - 101	0.43 (10)	**Yes**
Barium	15 / 15	15	46.0	NU	14.1 - 111	550 NC	No
Beryllium	2 / 15	15	0.567	0.05 - 0.94	1.90 - 3.80	0.15	**Yes**
Cadmium	3 / 13	13	0.771	0.20 - 0.76	0.710 - 5.40	3.9 NC	**Yes**
Calcium	14 / 15	15	55,500	491	643 - 215,000	NA	NA
Chromium	7 / 15	15	25.4	9.2 - 13.5	12.0 - 100	39 NC (11)	**Yes**
Cobalt	9 / 15	15	8.39	2.3 - 8.9	3.40 - 48.6	470 NC	No
Copper	12 / 15	15	36.6	6.4 - 20.4	8.10 - 215	310 NC	No
Iron	15 / 15	15	10,500	NU	3,860 - 33,600	NA (9)	NA
Lead	14 / 15	15	86.9	10.5	10.6 - 554	400 (11)	**Yes**
Magnesium	15 / 15	15	2,500	NU	915 - 5,440	NA	NA
Manganese	15 / 15	15	437	NU	54.4 - 2,750	187 NC	**Yes**
Mercury	3 / 13	13	0.103	0.06 - 0.12	0.110 - 0.480	2.3 NC (13)	No
Nickel	4 / 15	15	18.0	4.1 - 15.8	19.0 - 132	160 NC	No
Potassium	13 / 15	15	748	361 - 368	495 - 1,780	NA	NA
Selenium	5 / 15	15	1.55	0.67 - 5.6	0.810 - 7.20	39 NC	No
Sodium	1 / 14	14	234	114 - 514	1,670	NA	NA
Vanadium	15 / 15	15	24.1	NU	7.30 - 110	55 NC	**Yes**
Zinc	13 / 15	15	105	11.7 - 20.2	39.4 - 504	2,300 NC	No

TABLE 6-6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Central Wetlands Area							
Volatile Organics (μg/kg)							
Acetone	3 / 26	26	52.8	13 - 1,100	15 - 52	780,000 NC	No
2-Butanone	6 / 27	27	31.9	13 - 120	16 - 300	4,700,000 NC	No
Chlorobenzene	1 / 27	27	16.2	13 - 120	9.0	160,000 NC	No
Semivolatile Organics (μg/kg)							
Acenaphthene	15 / 28	28	924	420 - 18,000	28 - 2,600	470,000 NC	No
Acenaphthylene	3 / 27	27	952	390 - 18,000	53 - 2,200	230,000 NC (5)	No
Anthracene	15 / 28	28	986	420 - 18,000	37 - 5,200	2,300,000 NC	No
Benzo(a)anthracene	16 / 28	28	2,440	420 - 18,000	150 - 40,000	880	**Yes**
Benzo(a)pyrene	16 / 28	28	1,530	420 - 18,000	73 - 18,000	88	**Yes**
Benzo(b)fluoranthene	17 / 29	29	3,100	420 - 18,000	150 - 60,000	880	**Yes**
Benzo(g,h,i)perylene	9 / 27	27	1,470	420 - 31,000	44 - 740	230,000 NC (5)	No
Benzo(k)fluoranthene	15 / 28	28	1,520	420 - 31,000	82 - 2,500	8,800	No
Bis(2-chloroethyl) ether	1 / 27	27	1,490	390 - 31,000	550	580	No
Bis(2-ethylhexyl)phthalate	11 / 27	27	1,670	390 - 18,000	62 - 17,000	46,000	No
Butylbenzylphthalate	4 / 28	28	1,470	390 - 31,000	41 - 1,800	1,600,000 NC	No
Carbazole	7 / 27	27	929	420 - 18,000	31 - 2,300	32,000	No
Chrysene	21 / 29	29	1,810	420 - 18,000	19 - 25,000	88,000	No
Dibenzo(a,h)anthracene	3 / 27	27	1,480	420 - 31,000	84 - 140	88	**Yes**
Dibenzofuran	12 / 28	28	864	420 - 18,000	35 - 1,600	31,000 NC	No
1,2-Dichlorobenzene	1 / 27	27	1,500	390 - 31,000	750	700,000 NC	No
1,4-Dichlorobenzene	1 / 27	27	1,480	390 - 31,000	230	27,000	No
Fluoranthene	26 / 29	29	2,860	420 - 12,000	36 - 48,000	310,000 NC	No
Fluorene	16 / 28	28	684	420 - 12,000	51 - 3,300	310,000 NC	No
Indeno(1,2,3-cd)pyrene	11 / 27	27	1,560	420 - 18,000	54 - 18,000	880	**Yes**
2-Methylnaphthalene	11 / 27	27	901	420 - 18,000	21 - 1,500	230,000 NC (5)	No
4-Methylphenol	6 / 27	27	952	390 - 18,000	76 - 2,900	39,000 NC	No
N-Nitrosodiphenylamine	4 / 27	27	1,450	390 - 31,000	100 - 300	130,000	No
Naphthalene	14 / 27	27	896	420 - 18,000	31 - 2,300	310,000 NC	No
Phenanthrene	24 / 28	28	2,180	420 - 12,000	19 - 36,000	230,000 NC (5)	No
Pyrene	26 / 29	29	3,290	420 - 12,000	44 - 62,000	230,000 NC	No

TABLE 6-6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Pesticides and PCBs (μg/kg)							
Aldrin	2 / 27	27	1.96	2.0 - 19	0.080 - 0.16	38	No
PCBs	14 / 28	28	54.0	39 - 92	3.8 - 570	83 (8)	**Yes**
alpha-BHC	1 / 27	27	2.0	2.0 - 19	0.25	100	No
beta-BHC	1 / 27	27	2.0	2.0 - 19	0.19	350	No
delta-BHC	2 / 27	27	1.83	2.0 - 19	0.62 - 3.3	100 (7)	No
gamma-BHC(Lindane)	2 / 27	27	2.05	2.0 - 19	0.23 - 8.3	490	No
alpha-Chlordane	4 / 27	27	1.63	2.0 - 14	0.17 - 3.4	490 (6)	No
gamma-Chlordane	4 / 27	27	1.61	2.0 - 14	0.40 - 1.7	490 (6)	No
4,4'-DDD	13 / 27	27	9.23	3.9 - 13	0.23 - 83	2,700	No
4,4'-DDE	15 / 27	27	5.42	3.9 - 7.1	0.29 - 47	1,900	No
Dieldrin	10 / 27	27	4.37	3.9 - 37	0.14 - 17	40	No
Endosulfan II	6 / 27	27	2.76	3.9 - 13	0.24 - 8.0	47,000 NC (14)	No
Endosulfan Sulfate	1 / 27	27	3.55	3.9 - 37	1.5	47,000 NC (14)	No
Endrin	8 / 27	27	4.11	3.9 - 37	0.16 - 15	2,300 NC	No
Endrin Aldehyde	3 / 27	27	11.2	3.9 - 37	8.2 - 190	2,300 NC (15)	No
Endrin Ketone	1 / 27	27	3.91	3.9 - 37	3.7	2,300 NC (15)	No
Heptachlor Epoxide	5 / 27	27	1.48	2.0 - 14	0.12 - 0.93	70	No
Methoxychlor	1 / 27	27	17.9	20 - 140	26	39,000 NC	No
Inorganics (mg/kg)							
Aluminum	29 / 29	29	6,950	NU	3,050 - 30,200	NA (9)	NA
Antimony	8 / 26	26	12.0	2.3 - 34.1	3.18 - 158	3.1 NC	**Yes**
Arsenic	29 / 29	29	14.9	NU	2.60 - 40.8	0.43 (10)	**Yes**
Barium	29 / 29	29	61.7	NU	11.9 - 197	550 NC	No
Beryllium	7 / 27	27	0.620	0.10 - 1.7	0.510 - 3.70	0.15	**Yes**
Cadmium	2 / 25	25	0.460	0.30 - 2.6	1.20 - 3.40	3.9 NC	No
Calcium	26 / 29	29	3,020	629 - 800	518 - 11,100	NA	NA
Chromium	13 / 29	29	20.6	5.3 - 16.8	13.8 - 106	39 NC (11)	**Yes**
Cobalt	20 / 29	29	7.89	2.9 - 5.3	3.20 - 24.7	470 NC	No
Copper	21 / 29	29	259	6.1 - 25.6	6.60 - 3,600	310 NC	**Yes**
Cyanide	1 / 24	24	0.540	0.60 - 4.4	1.20	160 NC (16)	No
Iron	29 / 29	29	13,600	NU	4,680 - 50,200	NA (9)	NA

TABLE 6-6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Lead	29 / 29	29	302	NU	5.70 - 2,970	400 (12)	**Yes**
Magnesium	29 / 29	29	2,050	NU	936 - 7,400	NA	NA
Manganese	29 / 29	29	322	NU	49.0 - 1,230	187 NC	**Yes**
Mercury	15 / 29	29	0.159	0.05 - 0.09	0.070 - 0.950	2.3 NC (13)	No
Nickel	7 / 29	29	11.6	5.4 - 41.2	14.6 - 45.3	160 NC	No
Potassium	28 / 29	29	864	366	277 - 4,630	NA	NA
Selenium	17 / 28	28	2.05	0.57 - 2.8	0.605 - 10.2	39 NC	No
Silver	2 / 25	25	0.901	0.90 - 6.0	0.830 - 2.90	39 NC	No
Sodium	1 / 27	27	232	81 - 1,170	1,700	NA	NA
Vanadium	29 / 29	29	15.9	NU	5.70 - 52.5	55 NC	No
Zinc	28 / 29	29	167	19.5	23.2 - 998	2,300 NC	No
East Middlesex Canal and Wetlands Area							
Volatile Organics (μg/kg)							
Acetone	18 / 36	36	56.0	12 - 100	7.0 - 503	780,000 NC	No
Benzene	8 / 36	36	15.6	12 - 100	3.0 - 54	22,000	No
Bromomethane	1 / 36	36	15.7	12 - 100	44	11,000 NC	No
2-Butanone	14 / 41	41	30.6	12 - 91	15 - 210	4,700,000 NC	No
Chlorobenzene	2 / 36	36	15.3	12 - 100	7.0 - 39	160,000 NC	No
Chloromethane	1 / 36	36	14.8	12 - 100	14	49,000	No
1,2-Dichloroethene(total)	1 / 36	36	16.0	12 - 100	70	70,000	No
Ethylbenzene	4 / 36	36	27.2	12 - 100	14 - 440	780,000 NC	No
Methylene Chloride	1 / 36	36	14.7	12 - 100	18	85,000	No
1,1,2,2-Tetrachloroethane	2 / 36	36	17.8	12 - 100	80	3,200	No
Toluene	12 / 37	37	27.4	12 - 100	4.0 - 200	1,600,000 NC	No
1,1,1-Trichloroethane	1 / 37	37	14.6	12 - 100	10	700,000 NC	No
Xylenes (total)	7 / 36	36	57.3	12 - 100	9.0 - 990	16,000,000 NC	No
Semivolatile Organics (μg/kg)							
Acenaphthene	3 / 38	38	3,270	380 - 91,000	160 - 6,550	470,000 NC	No
Acenaphthylene	1 / 38	38	3,400	380 - 91,000	180	230,000 NC (5)	No
Anthracene	5 / 38	38	3,240	380 - 91,000	25 - 6,350	2,300,000 NC	No
Benzo(a)anthracene	14 / 38	38	3,950	380 - 91,000	38 - 21,000	880	**Yes**
Benzo(a)pyrene	15 / 38	38	3,620	380 - 91,000	36 - 15,000	88	**Yes**

TABLE 6-6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Benzo(b)fluoranthene	18 / 37	37	3,780	380 - 91,000	42 - 19,000	880	**Yes**
Benzo(g,h,i)perylene	6 / 37	37	3,460	380 - 91,000	130 - 8,950	230,000 NC (5)	No
Benzo(k)fluoranthene	7 / 37	37	3,680	380 - 91,000	73 - 12,500	8,800	**Yes**
Bis(2-ethylhexyl)phthalate	7 / 38	38	3,200	380 - 91,000	58 - 2,800	46,000	No
Butylbenzylphthalate	1 / 39	39	3,340	380 - 91,000	910	1,600,000 NC	No
Carbazole	1 / 38	38	3,400	380 - 91,000	270	32,000	No
Chrysene	16 / 38	38	3,740	380 - 91,000	27 - 20,000	88,000	No
Dibenzo(a,h)anthracene	5 / 37	37	3,160	380 - 91,000	90 - 2,950	88	**Yes**
Dibenzofuran	6 / 38	38	3,030	380 - 91,000	50 - 1,300	31,000 NC	No
Fluoranthene	21 / 38	38	4,430	380 - 91,000	23 - 32,500	310,000 NC	No
Fluorene	6 / 38	38	3,240	380 - 91,000	39 - 6,600	310,000 NC	No
Indeno(1,2,3-cd)pyrene	9 / 37	37	3,360	380 - 91,000	38 - 7,700	880	**Yes**
2-Methylnaphthalene	7 / 38	38	3,350	380 - 91,000	40 - 190	230,000 NC (5)	No
4-Methylphenol	7 / 39	39	3,290	380 - 91,000	50 - 720	39,000 NC	No
Naphthalene	17 / 38	38	3,290	380 - 91,000	19 - 650	310,000 NC	No
Phenanthrene	18 / 38	38	4,390	380 - 91,000	26 - 31,500	230,000 NC (5)	No
Pyrene	23 / 38	38	5,440	380 - 91,000	17 - 48,000	230,000 NC	No
Pesticides and PCBs (μg/kg)							
Aldrin	2 / 38	38	2.60	2.0 - 32	0.31 - 2.4	38	No
PCBs	7 / 37	37	75.2	38 - 620	19 - 480	83 (8)	**Yes**
beta-BHC	2 / 38	38	2.38	2.0 - 32	0.22 - 0.33	350	No
delta-BHC	5 / 38	38	2.34	2.0 - 32	0.13 - 2.3	100 (7)	No
alpha-Chlordane	5 / 38	38	2.27	2.0 - 32	0.21 - 1.9	490 (6)	No
gamma-Chlordane	15 / 38	38	1.66	2.0 - 32	0.13 - 2.8	490 (6)	No
4,4'-DDD	19 / 38	38	5.70	3.8 - 62	0.26 - 37	2,700	No
4,4'-DDE	23 / 38	38	4.81	3.8 - 62	0.16 - 20	1,900	No
4,4'-DDT	5 / 38	38	4.43	3.8 - 62	0.28 - 9.6	1,900	No
Dieldrin	11 / 38	38	4.41	3.8 - 62	0.30 - 10	40	No
Endosulfan I	8 / 38	38	2.07	2.0 - 32	0.24 - 3.4	47,000 NC	No
Endosulfan II	4 / 38	38	4.84	3.8 - 62	0.34 - 9.4	47,000 NC (14)	No
Endosulfan Sulfate	4 / 38	38	4.78	3.8 - 62	0.30 - 1.8	47,000 NC (14)	No
Endrin	5 / 38	38	5.17	3.8 - 62	0.12 - 14	2,300 NC	No

TABLE 6-6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Soil RBC (4)	Maximum Detect > RBC?
Endrin Ketone	5 / 38	38	4.65	3.8 - 62	0.16 - 2.3	2,300 NC (15)	No
Heptachlor	1 / 38	38	2.65	2.0 - 32	0.54	140	No
Heptachlor Epoxide	10 / 38	38	1.96	2.0 - 32	0.19 - 0.74	70	No
Methoxychlor	9 / 38	38	20.7	20 - 320	0.22 - 14	39,000 NC	No
Inorganics (mg/kg)							
Aluminum	42 / 42	42	6,110	NU	1,145 - 32,300	NA (9)	NA
Arsenic	31 / 38	38	19.6	2.0 - 4.4	2.70 - 256	0.43 (10)	**Yes**
Barium	42 / 42	42	59.5	NU	8.20 - 287	550 NC	No
Beryllium	7 / 35	35	0.417	0.04 - 0.91	0.970 - 3.20	0.15	**Yes**
Cadmium	2 / 31	31	0.295	0.20 - 1.8	0.475 - 1.30	3.9 NC	No
Calcium	37 / 42	42	3,340	388 - 813	410 - 13,800	NA	NA
Chromium	6 / 32	32	11.1	1.7 - 15.8	14.7 - 64.6	39 NC (11)	**Yes**
Cobalt	16 / 34	34	5.33	1.6 - 6.2	2.33 - 19.9	470 NC	No
Copper	22 / 38	38	21.8	2.0 - 26	7.50 - 194	310 NC	No
Iron	42 / 42	42	11,200	NU	1,580 - 76,300	NA (9)	NA
Lead	41 / 42	42	53.0	5.3	3.60 - 400	400 (12)	No
Magnesium	42 / 42	42	1,910	NU	173 - 10,500	NA	NA
Manganese	42 / 42	42	383	NU	18.3 - 2,700	187 NC	**Yes**
Mercury	18 / 36	36	0.202	0.06 - 0.13	0.060 - 1.30	2.3 NC (13)	No
Nickel	5 / 32	32	8.13	2.6 - 11.1	20.1 - 46.7	160 NC	No
Potassium	29 / 37	37	952	126 - 593	303 - 7,400	NA	NA
Selenium	7 / 31	31	0.952	0.50 - 3.0	1.00 - 2.50	39 NC	No
Silver	3 / 31	31	0.969	0.80 - 2.1	1.80 - 6.70	39 NC	No
Sodium	4 / 33	33	375	105 - 1,880	1,770 - 2,190	NA	NA
Vanadium	39 / 39	39	15.6	NU	2.70 - 76.4	55 NC	**Yes**
Zinc	26 / 37	37	61.5	4.5 - 38.5	7.80 - 669	2,300 NC	No

NOTES:

1. The number of samples in which the contaminant was detected divided by the total number of samples analyzed, excluding rejected samples, for sampling rounds in June and September, 1993.
2. The number of samples used in calculating the mean.
3. The arithmetic mean was calculated using the detected concentrations and one-half the detection limit for non-detect samples. In some cases, high detection limits resulted in the calculation of arithmetic means above maximum detected concentrations.

TABLE 6-6 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

NOTES (continued):

4. Region III residential soil RBCs were used. RBCs for noncarcinogenic chemicals, indicated by NC, are based on a hazard quotient of 0.1, following EPA Region I guidance. Therefore, the soil RBCs reported by Region III were divided by 10 for these noncarcinogenic chemicals.
5. The RBC for pyrene was used for noncarcinogenic PAHs that lack RBCs.
6. The RBC for chlordane was used.
7. The RBC for alpha-BHC was used.
8. The RBC for carcinogenic PCBs was used.
9. The RBC is based on provisional toxicity criteria and was not used since Region I does not concur with the use of this value in a risk assessment.
10. The RBC for arsenic as a carcinogen was used.
11. The RBC for chromium VI was used.
12. Because no RBC exists for lead, a residential soil screening level for lead of 400 mg/kg (U.S. EPA, 1994d) was used.
13. The RBC for inorganic mercury was used.
14. The RBC for endosulfan I was used.
15. The RBC for endrin was used.
16. The RBC for free cyanide was used.
17. This chemical was selected as a chemical of potential concern because it lacks an RBC and could not be screened.

NU = Not used; chemical was detected in all samples.
PCBs = Polychlorinated Biphenyls, or Aroclors.
RBC = Risk-based concentration.
NC = Noncarcinogenic Chemicals
NA = Not applicable. RBCs were not available for calcium, magnesium, potassium, and sodium, which are essential human nutrients. Detected concentrations of nutrients were compared to allowable daily intake (ADI) levels. In addition, an RBC was not available for 2-hexanone.
Yes = The maximum detected concentration of this chemical was detected above the residential soil RBC, therefore the chemical was selected as a chemical of potential concern (COPC). COPCs were not selected in background data.
No = This chemical was detected below residential soil RBCs, therefore the chemical was eliminated as a chemical of potential concern.

TABLE 6-7. SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Detect > RBC?
Background							
Semivolatile Organics (µg/l)							
Bis(2-ethylhexyl)phthalate	1 / 4	4	3.95	10	0.80	4.8	No
Benzo(b)fluoranthene	1 / 4	4	3.92	10	0.70	0.092	**Yes**
Fluoranthene	2 / 4	4	2.90	10	0.60 - 1.0	150 NC	No
Phenanthrene	1 / 4	4	3.90	10	0.60	110 NC (5)	No
Pyrene	2 / 4	4	2.98	10	0.90 - 1.0	110 NC	No
Pesticides and PCBs (µg/l)							
alpha-BHC	1 / 4	4	0.00150	0.0025 - 0.0030	0.0020	0.011	No
alpha-Chlordane	2 / 4	4	0.00313	0.0025 - 0.0030	0.00075 - 0.0090	0.052 (6)	No
gamma-Chlordane	1 / 4	4	0.00375	0.0025 - 0.0030	0.011	0.052 (6)	No
4,4'-DDE	1 / 4	4	0.00337	0.0050	0.0060	0.2	No
Endosulfan II	1 / 4	4	0.00215	0.0050	0.0011	22 NC (7)	No
Endrin Aldehyde	1 / 4	4	0.00337	0.0050	0.0060	1.1 NC (8)	No
Inorganics (µg/l)							
Aluminum	4 / 4	4	6,810	NU	888 - 18,500	NA (9)	NA
Arsenic	2 / 4	4	15.3	2.70 - 3.60	18.1 - 39.8	0.045 (10)	**Yes**
Barium	4 / 4	4	128	NU	33.1 - 285	260 NC	**Yes**
Beryllium	2 / 4	4	1.06	0.200 - 0.440	1.10 - 2.80	0.016	**Yes**
Calcium	4 / 4	4	18,400	NU	9,980 - 27,900	NA	NA
Chromium	3 / 4	4	10.3	4.10	3.50 - 25.9	18 NC (11)	**Yes**
Cobalt	2 / 4	4	27.2	2.90 - 3.0	33.2 - 72.5	220 NC	No
Copper	1 / 4	4	11.4	6.10 - 50.8	7.80	150 NC	No
Iron	4 / 4	4	26,000	NU	2,830 - 71,200	NA (9)	NA
Lead	4 / 4	4	54.4	NU	22.3 - 122	50 (12)	**Yes**
Magnesium	4 / 4	4	4,040	NU	2,120 - 6,570	NA	NA
Manganese	4 / 4	4	3,310	NU	315 - 6,740	86	**Yes**
Nickel	3 / 4	4	18.5	3.90	5.10 - 48.2	73 NC	No
Potassium	4 / 4	4	3,170	NU	2,190 - 4,500	NA	NA
Sodium	4 / 4	4	27,400	NU	23,000 - 37,200	NA	NA
Thallium	1 / 4	4	1.35	1.40 - 2.0	2.90	0.29 NC (13)	**Yes**
Vanadium	2 / 4	4	19.0	7.10 - 8.80	19.0 - 49.1	26 NC	**Yes**

TABLE 6-7(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Detect > RBC?
Zinc	4 / 4	4	189	NU	27.8 - 505	1,100 NC	No
West Middlesex Canal Area							
Pesticides and PCBs (µg/l)							
Aldrin	1 / 8	8	0.00124	0.0025 - 0.0030	0.00064	0.004	No
delta-BHC	1 / 11	11	0.00268	0.0025 - 0.0030	0.016	0.011 (14)	**Yes**
gamma-BHC(Lindane)	1 / 11	11	0.00134	0.0025 - 0.0030	0.0010	0.052	No
alpha-Chlordane	2 / 11	11	0.00128	0.0025 - 0.0030	0.00063 - 0.0010	0.052 (6)	No
Dieldrin	1 / 11	11	0.00247	0.0050	0.0022	0.0042	No
Endrin	2 / 11	11	0.00280	0.0050	0.0032 - 0.0051	1.1 NC	No
Heptachlor Epoxide	2 / 11	11	0.00145	0.0025 - 0.0030	0.0015 - 0.0019	0.0012	**Yes**
Methoxychlor	1 / 11	11	0.0128	0.025 - 0.030	0.0029	18 NC	No
PCBs	1 / 11	11	0.0382	0.05	0.17	0.0087 (15)	**Yes**
Inorganics (µg/l)							
Aluminum	8 / 11	11	750	53.3 - 111	193 - 1,730	NA (9)	NA
Arsenic	3 / 11	11	11.6	2.10 - 12.3	22.1 - 43.3	0.045 (10)	**Yes**
Barium	11 / 11	11	43.4	NU	21.9 - 100	260 NC	No
Calcium	11 / 11	11	13,500	NU	11,800 - 14,600	NA	NA
Chromium	2 / 11	11	2.20	1.80 - 3.30	4.80 - 7.10	18 NC (11)	No
Iron	11 / 11	11	6,000	NU	1,430 - 15,500	NA (9)	NA
Lead	4 / 11	11	9.47	2.80 - 11.2	10.90 - 27.8	50 (12)	No
Magnesium	11 / 11	11	2,630	NU	2,270 - 3,040	NA	NA
Manganese	11 / 11	11	982	NU	349 - 3,530	86	**Yes**
Nickel	6 / 11	11	4.02	3.40 - 5.30	4.30 - 6.70	73 NC	No
Potassium	11 / 11	11	3,930	NU	2,840 - 12,000	NA	NA
Sodium	11 / 11	11	28,800	NU	25,500 - 31,600	NA	NA
Thallium	1 / 11	11	1.44	1.60 - 10.0	2.05	0.29 NC (13)	**Yes**
Vanadium	1 / 11	11	2.08	2.10 - 6.20	4.50	26 NC	No
Zinc	3 / 11	11	24.1	7.20 - 46.2	30.8 - 109	1,100 NC	No
Central Wetlands Area							
Volatile Organics (µg/l)							
Carbon Disulfide	1 / 29	29	5.0	10	5.0	100 NC	No
Chlorobenzene	1 / 29	29	4.90	10	2.0	3.9 NC	No

TABLE 6-7(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Detect > RBC?
1,1-Dichloroethane	2 / 29	29	5.09	10	2.0 - 10.5	81 NC	No
1,2-Dichloroethene(total)	2 / 29	29	5.43	10	11 - 11.5	5.5 NC	**Yes**
Methylene Chloride	1 / 29	29	5.17	10	10	4.1	**Yes**
Tetrachloroethene	3 / 29	29	5.52	10	2.0 - 16	1.1	**Yes**
1,1,1-Trichloroethane	6 / 29	29	5.48	10	1.0 - 20	130 NC	No
Trichloroethene	2 / 29	29	5.22	10	8.0 - 8.5	1.6	**Yes**
Semivolatile Organics (μg/l)							
Acenaphthene	1 / 29	29	4.84	10	0.50	220 NC	No
Benzo(b)fluoranthene	1 / 29	29	4.86	10	1.0	0.092	**Yes**
Bis(2-ethylhexyl)phthalate	2 / 29	29	4.79	10 - 15	0.50 - 1.0	4.8	No
Fluoranthene	1 / 29	29	4.85	10	0.70	150 NC	No
Phenanthrene	1 / 29	29	4.86	10	0.80	110 NC (5)	No
Pyrene	3 / 29	29	4.59	10	1.0	110 NC	No
Pesticides and PCBs (μg/l)							
Aldrin	1 / 24	24	0.00132	0.0025 - 0.0030	0.00069	0.004	No
alpha-BHC	2 / 28	28	0.00138	0.0025 - 0.0030	0.00100 - 0.0020	0.011	No
gamma-BHC(Lindane)	2 / 28	28	0.00163	0.0025 - 0.0030	0.0024 - 0.0074	0.052	No
alpha-Chlordane	1 / 28	28	0.00136	0.0025 - 0.0030	0.0012	0.052 (6)	No
4,4'-DDD	1 / 28	28	0.00260	0.0050	0.0053	0.28	No
4,4'-DDT	1 / 28	28	0.00248	0.0050	0.0020	0.2	No
Endosulfan II	2 / 28	28	0.00240	0.0050	0.0011	22 NC (7)	No
Endrin	6 / 28	28	0.00374	0.0050	0.0026 - 0.021	1.1 NC	No
Endrin Aldehyde	3 / 28	28	0.00268	0.0050	0.0026 - 0.0050	1.1 NC (8)	No
Inorganics (μg/l)							
Aluminum	18 / 29	29	613	47.7 - 158	108 - 6,200	NA (9)	NA
Arsenic	11 / 29	29	12.5	1.70 - 8.40	1.80 - 155	0.045 (10)	**Yes**
Barium	29 / 29	29	79.6	NU	20.1 - 842	260 NC	**Yes**
Cadmium	1 / 29	29	1.69	1.0 - 1.70	28.2	1.8 NC	**Yes**
Calcium	29 / 29	29	20,800	NU	6,160 - 56,300	NA	NA
Chromium	6 / 29	29	4.29	1.80 - 5.80	3.40 - 36.9	18 NC (11)	**Yes**
Cobalt	5 / 29	29	3.63	1.60 - 5.0	5.5 - 27.7	220 NC	No
Copper	3 / 29	29	28.1	2.50 - 32	26.5 - 636	150 NC	**Yes**

TABLE 6-7(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Detect > RBC?
Iron	29 / 29	29	9,550	NU	528 - 90,500	NA (9)	NA
Lead	11 / 29	29	34.6	2.40 - 13.9	15.1 - 630	50 (12)	Yes
Magnesium	29 / 29	29	3,540	NU	1,260 - 11,700	NA	NA
Manganese	29 / 29	29	1,080	NU	145 - 4,810	86	Yes
Mercury	2 / 29	29	0.0821	0.100 - 0.200	0.150 - 0.180	1.1 NC (16)	No
Nickel	8 / 29	29	14.7	3.40 - 6.30	4.80 - 324	73 NC	Yes
Potassium	29 / 29	29	3,190	NU	1,600 - 7,570	NA	NA
Selenium	4 / 29	29	1.65	2.30 - 6.10	2.40 - 3.60	18 NC	No
Silver	1 / 29	29	1.86	2.60 - 4.70	6.50	18 NC	No
Sodium	29 / 29	29	71,600	NU	10,100 - 205,000	NA	NA
Thallium	2 / 29	29	1.60	1.60 - 10	2.30 - 2.90	0.29 NC (13)	Yes
Vanadium	5 / 29	29	3.42	2.10 - 5.50	3.40 - 38.9	26 NC	Yes
Zinc	12 / 29	29	204	6.70 - 45.6	17.2 - 5,100	1,100 NC	Yes
<u>East Middlesex Canal and Wetlands Area</u>							
Volatile Organics (µg/l)							
Benzene	2 / 41	41	4.80	10	1.0	0.36	Yes
Carbon Disulfide	1 / 41	41	4.90	10	1.0	100 NC	No
Chloromethane	1 / 41	41	4.95	10	3.0	1.4	Yes
Ethylbenzene	1 / 41	41	5.90	10	42	130 NC	No
Toluene	4 / 41	41	5.10	10	1.0 - 10	75 NC	No
Xylenes (total)	4 / 41	41	8.29	10	4.0 - 120	1,200 NC	No
Semivolatile Organics (µg/l)							
Acenaphthene	1 / 41	41	4.90	10	0.90	220 NC	No
Benzo(a)anthracene	1 / 41	41	4.90	10	1.0	0.092	Yes
Benzo(b)fluoranthene	1 / 41	41	4.93	10	2.0	0.092	Yes
Bis(2-ethylhexyl)phthalate	1 / 41	41	5.05	10 - 23	0.70	4.8	No
Chrysene	2 / 41	41	4.80	10	1.0	9.2	No
1,4-Dichlorobenzene	2 / 41	41	4.83	10	1.0 - 2.0	0.44	Yes
2,4-Dimethylphenol	1 / 41	41	5.05	10	7.0	73 NC	No
Fluoranthene	4 / 41	41	4.61	10	0.40 - 2.0	150	No
4-Methylphenol	2 / 41	41	16.5	10	43 - 440	18 NC	Yes
Naphthalene	7 / 41	41	4.40	10	0.40 - 4.0	150 NC	No

TABLE 6-7(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Detect > RBC?
Phenanthrene	4 / 41	41	4.59	10	0.40 - 1.0	110 NC (5)	No
Phenol	1 / 41	41	7.22	10	96	2,200 NC	No
Pyrene	4 / 41	41	4.62	10	0.60 - 2.0	110 NC	No
Pesticides and PCBs (μg/l)							
Aldrin	1 / 26	26	0.00179	0.0025 - 0.0030	0.014	0.004	**Yes**
PCBs	1 / 40	40	0.0304	0.050	0.24	0.0087 (15)	**Yes**
alpha-BHC	3 / 40	40	0.00153	0.0025 - 0.0030	0.0015 - 0.0060	0.011	No
gamma-BHC(Lindane)	5 / 39	39	0.00379	0.0025 - 0.0030	0.0016 - 0.066	0.052	**Yes**
alpha-Chlordane	2 / 40	40	0.00153	0.0025 - 0.0030	0.0043 - 0.0050	0.052 (6)	No
gamma-Chlordane	4 / 40	40	0.00164	0.0025 - 0.0030	0.0022 - 0.0049	0.052 (6)	No
4,4'-DDD	3 / 40	40	0.00317	0.0050	0.0040 - 0.025	0.28	No
4,4'-DDT	3 / 40	40	0.00271	0.0050	0.0038 - 0.0070	0.2	No
Endosulfan I	3 / 40	40	0.00137	0.0025 - 0.0030	0.0011 - 0.0014	22 NC	No
Endosulfan II	5 / 40	40	0.00250	0.0050	0.0017 - 0.0045	22 NC (7)	No
Endrin	9 / 40	40	0.00280	0.0050	0.0017 - 0.0120	1.1 NC	No
Endrin Aldehyde	1 / 40	40	0.00263	0.0050	0.0078	1.1 NC (8)	No
Methoxychlor	1 / 32	32	0.0144	0.025 - 0.030	0.025	18 NC	No
Inorganics (μg/l)							
Aluminum	20 / 41	41	3,790	11.5 - 100	17.4 - 65,000	NA (9)	NA
Antimony	4 / 41	41	8.61	9.20 - 18.6	14.0 - 30.2	1.5 NC	**Yes**
Arsenic	27 / 41	41	436	2.10 - 8.80	2.0 - 13,000	0.045 (10)	**Yes**
Barium	40 / 41	41	488	16.3	9.30 - 10,300	260 NC	**Yes**
Beryllium	2 / 41	41	0.254	0.200 - 3.20	0.400 - 1.60	0.016	**Yes**
Calcium	41 / 41	41	36,500	NU	3,330 - 226,000	NA	NA
Chromium	9 / 41	41	9.64	2.10 - 6.70	4.30 - 133	18 NC (11)	**Yes**
Cobalt	9 / 41	41	5.23	2.60 - 3.80	4.30 - 51.6	220 NC	No
Copper	4 / 41	41	13.7	2.50 - 45.0	3.70 - 299	150 NC	**Yes**
Iron	41 / 41	41	76,500	NU	329 - 1,290,000	NA (9)	NA
Lead	10 / 41	41	42.8	1.10 - 8.50	18.6 - 551	50 (12)	**Yes**
Magnesium	41 / 41	41	10,900	NU	942 - 75,300	NA	NA
Manganese	40 / 41	41	1,440	18.2	93.7 - 13,500	86	**Yes**
Mercury	1 / 41	41	0.0771	0.100 - 0.200	0.160	1.1 NC (16)	No

TABLE 6-7(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Detect > RBC?
Nickel	10 / 41	41	11.4	3.40 - 45.5	4.50 - 118	73 NC	Yes
Potassium	41 / 41	41	18,100	NU	996 - 130,000	NA	NA
Selenium	5 / 41	41	2.70	2.30 - 3.70	2.50 - 27.6	18 NC	Yes
Silver	5 / 41	41	4.56	2.60 - 4.70	5.10 - 54.0	18 NC	Yes
Sodium	41 / 41	41	86,600	NU	18,600 - 444,000	NA	NA
Thallium	1 / 41	41	1.69	1.10 - 7.0	23.8	0.29 NC (13)	Yes
Vanadium	12 / 41	41	14.3	2.10 - 5.50	2.80 - 211	26 NC	Yes
Zinc	9 / 41	41	104	3.40 - 51.2	12.9 - 2,780	1,100 NC	Yes

NOTES:

1. The number of samples in which contaminant was detected divided by total number of samples analyzed (6/93 & 9/93), excluding rejected samples.
2. The number of samples used in calculating the mean.
3. The arithmetic mean was calculated using the detected concentrations and one-half the detection limit for non-detect samples. In some cases, high detection limits resulted in the calculation of arithmetic means above maximum detected concentrations.
4. Region III residential soil RBCs were used. RBCs for noncarcinogenic chemicals, indicated by NC, are based on a hazard quotient of 0.1, following EPA Region I guidance. Therefore, the RBCs reported by Region III were divided by 10 for these noncarcinogenic chemicals.
5. The RBC for pyrene was used for noncarcinogenic PAHs that lack RBCs.
6. The RBC for chlordane was used.
7. The RBC for endosulfan I was used.
8. The RBC for endrin was used.
9. The RBC is based on provisional toxicity criteria and were not used since Region I does not concur with the use of this value in a risk assessment.
10. The RBC for arsenic as a carcinogen was used.
11. The RBC for chromium VI was used.
12. Because no tap water RBC for lead exists, the water quality criteria (for water and organisms) for lead of 50 ug/l was used (U.S. EPA, 1996h).
13. The RBC for thallium carbonate, thallium chloride or thallium sulfate was used.
14. The RBC for alpha-BHC was used.
15. The RBC for carcinogenic PCBs was used.
16. The RBC for inorganic mercury was used.

NC = Noncarcinogenic Chemicals
NU = Not used; chemical was detected in all samples.
PCBs = Polychlorinated Biphenyls, or Aroclors.
RBC = Risk-based concentration.

TABLE 6-7(Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

NOTES (continued):

NA = Not applicable. RBCs are not available for calcium, magnesium, potassium, and sodium, which are essential human nutrients. Detected concentrations of nutrients were compared to allowable daily intake (ADI) levels.

Yes = The maximum detected concentration of this chemical was detected above the residential tap water RBC, therefore the chemical was selected as a chemical of potential concern (COPC). COPCs were not selected in background data.

No = This chemical was detected below residential tap water RBCs, therefore the chemical was eliminated as a chemical of potential concern.

TABLE 6-8. SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Background - Shallow Overburden								
Pesticides and PCBs (µg/l)								
PCBs	1 / 2	2	0.0225	0.050	0.02	0.0087 (5)	0.5	**Yes**
Inorganics (µg/l)								
Barium	2 / 2	2	21.0	NU	14.9 - 27.1	260 NC	2,000	No
Calcium	2 / 2	2	27,500	NU	22,700 - 32,300	NA	---	NA
Magnesium	2 / 2	2	6,320	NU	3,410 - 9,230	NA	---	NA
Manganese	2 / 2	2	661	NU	141 - 1,180	86 NC	---	**Yes**
Potassium	1 / 2	2	2,330	2,990	3,170	NA	---	NA
Sodium	2 / 2	2	9,120	NU	5,740 - 12,500	NA	---	NA
Background - Deep Overburden								
Inorganics (µg/l)								
Aluminum	1 / 2	2	762	169	1,440	NA (6)	---	NA
Arsenic	2 / 2	2	46.9	NU	45.2 - 48.5	0.045 (7)	50	**Yes**
Barium	1 / 2	2	6.23	3.7	10.6	260 NC	2,000	No
Calcium	2 / 2	2	11,700	NU	11,100 - 12,300	NA	---	NA
Copper	1 / 2	2	16.7	1.5	32.6	150 NC	---	No
Iron	1 / 2	2	949	177	1,810	NA (6)	---	NA
Lead	1 / 2	2	6.65	1.6	12.5	15 (8)	---	No
Magnesium	2 / 2	2	1,880	NU	1,660 - 2,100	NA	---	NA
Manganese	1 / 2	2	13.8	26.1	14.5	86 NC	---	No
Potassium	2 / 2	2	2,120	NU	1,970 - 2,280	NA	---	NA
Sodium	2 / 2	2	21,200	NU	18,500 - 23,900	NA	---	NA
Vanadium	2 / 2	2	3.15	NU	2.70 - 3.60	26 NC	---	No
Zinc	1 / 2	2	18.9	1.2	37.2	1100 NC	---	No
Background - Bedrock								
Volatile Organics (µg/l)								
Carbon Disulfide	1 / 2	2	6.0	10	7.0	100 NC	---	No
Pesticides and PCBs (µg/l)								
PCBs	1 / 2	2	0.0195	0.060	0.0090	0.0087 (5)	0.5	**Yes**
Inorganics (µg/l)								
Arsenic	1 / 4	4	4.31	2.7 - 8.0	7.90	0.045 (7)	50	**Yes**

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Barium	1 / 4	4	4.51	6.5 - 6.9	7.90	260 NC	2,000	No
Calcium	2 / 4	4	7,440	NU	2,840 - 12,700	NA	---	NA
Chromium	1 / 4	4	1.58	0.70 - 5.0	0.950	18 NC (9)	100 (18)	No
Iron	2 / 4	4	248	30 - 56.3	442 - 507	NA (6)	---	NA
Magnesium	2 / 4	4	1,700	NU	1,000 - 2,265	NA	---	NA
Manganese	2 / 4	4	31.7	21.6 - 34.3	46.2 - 52.8	86 NC	---	No
Potassium	2 / 4	4	1,350	516	455 - 2,730	NA	---	NA
Sodium	2 / 4	4	9,990	NU	5,410 - 16,900	NA	---	NA
Zinc	1 / 4	4	3.89	1.2 - 17.1	4.40	1100 NC	---	No
<u>B&M Railroad Landfill - Shallow Overburden</u>								
Volatile Organics (μg/l)								
Acetone	1 / 10	10	6.0	10	15	370 NC	---	No
Toluene	2 / 10	10	4.70	10	3.0 - 4.0	75 NC	1,000	No
Semivolatile Organics (μg/l)								
Acenaphthene	2 / 10	10	5.40	10	7.0	220 NC	---	No
Carbazole	2 / 10	10	4.90	10	3.0 - 6.0	3.4	---	**Yes**
Dibenzofuran	2 / 10	10	5.20	10	6.0	15 NC	---	No
2,4-Dimethylphenol	1 / 10	10	5.90	10	14	73 NC	---	No
Fluorene	3 / 10	10	4.80	10	1.0 - 6.0	150 NC	---	No
2-Methylnaphthalene	4 / 10	10	5.40	10	3.0 - 10	110 NC (10)	---	No
2-Methylphenol	1 / 10	10	5.10	10	6.0	180 NC	---	No
4-Methylphenol	2 / 10	10	8.10	10	4.0 - 37	18 NC	---	**Yes**
Naphthalene	4 / 10	10	19.9	10	34 - 54	150 NC	---	No
Phenanthrene	2 / 10	10	5.60	10	8.0	110 NC (10)	---	No
Pesticides and PCBs (μg/l)								
Aldrin	1 / 10	10	0.00255	0.003 - 0.006	0.010	0.004	---	**Yes**
alpha-Chlordane	1 / 10	10	0.00150	0.003 - 0.004	0.0010	0.052 (11)	2 (19)	No
gamma-Chlordane	1 / 10	10	0.00175	0.003 - 0.006	0.0020	0.052 (11)	2 (19)	No
4,4'-DDD	1 / 10	10	0.00565	0.005 - 0.010	0.030	0.28	---	No
Dieldrin	3 / 10	10	0.00271	0.005 - 0.006	0.00060 - 0.0040	0.0042	---	No
Endosulfan Sulfate	2 / 10	10	0.00295	0.005 - 0.007	0.0020 - 0.0050	22 NC (12)	---	No
Heptachlor Epoxide	1 / 10	10	0.00156	0.003 - 0.006	0.00010	0.0012	0.2	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Methoxychlor	1 / 10	10	0.0160	0.030 - 0.040	0.020	18 NC	40	No
PCBs	3 / 10	10	0.0495	0.050 - 0.060	0.060 - 0.15	0.0087 (5)	0.5	**Yes**
Inorganics (µg/l)								
Aluminum	1 / 10	10	68.1	25 - 235	246	NA (6)	---	NA
Antimony	1 / 10	10	1.73	1.9 - 5.5	4.70	1.5 NC	6	**Yes**
Arsenic	3 / 10	10	11.8	2.7 - 8.0	3.10 - 55.6	0.045 (7)	50	**Yes**
Barium	8 / 10	10	374	27 - 37.6	9.70 - 2,000	260 NC	2,000	**Yes**
Calcium	10 / 10	10	22,800	NU	6,280 - 88,500	NA	---	NA
Chromium	1 / 10	10	1.96	0.70 - 5.0	5.40	18 NC (9)	100 (18)	No
Cobalt	3 / 10	10	1.70	0.50 - 2.0	2.30 - 6.30	220 NC	---	No
Copper	1 / 10	10	6.73	0.50 - 3.0	57.8	150 NC	---	No
Iron	5 / 10	10	13,100	9.7 - 52.6	205 - 45,800	NA (6)	---	NA
Lead	5 / 10	10	6.78	1.6 - 3.0	1.90 - 32.7	15 (8)	---	**Yes**
Magnesium	10 / 10	10	4,520	NU	953 - 18,600	NA	---	NA
Manganese	7 / 10	10	1,230	0.36 - 2.6	12.5 - 5,420	86 NC	---	**Yes**
Nickel	2 / 10	10	5.86	2.4 - 10	12.0 - 21.8	73 NC	100	No
Potassium	9 / 10	10	6,140	602	589 - 27,200	NA	---	NA
Sodium	10 / 10	10	47,900	NU	8,210 - 219,000	NA	---	NA
Vanadium	2 / 10	10	0.928	0.60 - 2.0	0.860 - 2.50	26 NC	---	No
Zinc	4 / 10	10	73.8	1.2 - 4.0	106 - 347	1100 NC	---	No
B&M Railroad Landfill - Deep Overburden								
Volatile Organics (µg/l)								
Chlorobenzene	2 / 12	12	4.83	10	4.0	3.9 NC	---	**Yes**
1,1-Dichloroethane	4 / 12	12	4.62	10	2.0 - 5.5	81 NC	---	No
1,2-Dichloroethane	4 / 12	12	4.33	10	3.0	0.12	5	**Yes**
1,1-Dichloroethene	2 / 12	12	5.12	10	4.0 - 7.5	0.044	7	**Yes**
1,2-Dichloroethene(total)	2 / 12	12	4.67	10	3.0	5.5 NC	70 (20)	No
Trichloroethene	2 / 12	12	11.8	10	39 - 53	1.6	5	**Yes**
Pesticides and PCBs (µg/l)								
4,4'-DDT	1 / 12	12	0.00258	0.005 - 0.006	0.00090	0.2	---	No
Endosulfan Sulfate	2 / 12	12	0.00248	0.005 - 0.008	0.00020 - 0.00060	22 NC (12)	---	No
Heptachlor Epoxide	1 / 12	12	0.00154	0.003 - 0.004	0.0010	0.0012	0.2	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Methoxychlor	1 / 12	12	0.0153	0.030 - 0.040	0.0080	18 NC	40	No
PCBs	1 / 12	12	0.0267	0.050 - 0.060	0.020	0.0087 (5)	0.5	**Yes**
Inorganics (µg/l)								
Barium	9 / 12	12	26.3	5.9 - 21.2	5.90 - 73.2	260 NC	2,000	No
Calcium	12 / 12	12	32,200	NU	10,600 - 63,900	NA	---	NA
Chromium	1 / 12	12	2.61	0.70 - 5.0	16.2	18 NC (9)	100 (18)	No
Cobalt	5 / 12	12	1.98	0.50 - 2.0	1.40 - 7.50	220 NC	---	No
Copper	2 / 12	12	5.97	0.50 - 3.0	8.30 - 54.1	150 NC	---	No
Iron	7 / 12	12	96.1	14.5 - 50.3	83.8 - 324	NA (6)	---	NA
Lead	1 / 12	12	1.73	1.6 - 3.0	8.50	15 (8)	---	No
Magnesium	12 / 12	12	6,840	NU	2,200 - 12,200	NA	---	NA
Manganese	11 / 12	12	405	1.8	1.90 - 922	86 NC	---	**Yes**
Nickel	2 / 12	12	3.52	2.4 - 10	3.40 - 4.0	73 NC	100	No
Potassium	12 / 12	12	4,630	NU	1,190 - 9,550	NA	---	NA
Sodium	12 / 12	12	31,800	NU	11,700 - 79,400	NA	---	NA
Zinc	5 / 12	12	5.61	1.2 - 6.8	3.80 - 35.9	1100 NC	---	No
B&M Railroad Landfill - Bedrock								
Volatile Organics (µg/l)								
Chloroform	3 / 10	10	4.70	10	2.0 - 6.0	0.15	60	**Yes**
1,1-Dichloroethane	4 / 10	10	5.0	10	5.0	81 NC	---	No
1,2-Dichloroethane	4 / 10	10	5.90	10	6.0 - 9.0	0.12	5	**Yes**
1,1-Dichloroethene	4 / 10	10	5.10	10	3.0 - 9.0	0.044	7	**Yes**
1,2-Dichloroethene(total)	4 / 10	10	4.90	10	3.0 - 8.0	5.5 NC	70 (20)	**Yes**
Trichloroethene	4 / 10	10	16.6	10	22 - 50	1.6	5	**Yes**
Semivolatile Organics (µg/l)								
Bis(2-ethylhexyl)phthalate	1 / 10	10	6.15	10 - 24	9.0	4.8	---	**Yes**
Pesticides and PCBs (µg/l)								
delta-BHC	2 / 10	10	0.00150	0.003	0.0010 - 0.0020	0.011 (13)	---	No
gamma-Chlordane	1 / 10	10	0.00152	0.003 - 0.004	0.00070	0.052 (11)	2 (19)	No
4,4'-DDE	1 / 10	10	0.00265	0.005 - 0.006	0.0020	0.2	---	No
Inorganics (µg/l)								
Aluminum	1 / 10	10	56.5	25 - 197	225	NA (6)	---	NA

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Arsenic	4 / 10	10	6.82	2.7 - 10.1	3.80 - 19.6	0.045 (7)	50	**Yes**
Barium	6 / 10	10	18.0	1.0 - 4.2	3.90 - 73.4	260 NC	2,000	No
Calcium	10 / 10	10	40,600	NU	12,900 - 75,900	NA	---	NA
Cobalt	3 / 10	10	1.35	0.50 - 2.0	1.70 - 3.70	220 NC	---	No
Iron	6 / 10	10	433	9.7 - 45.2	41.6 - 2,010	NA (6)	---	NA
Lead	1 / 10	10	1.26	1.6 - 3.0	1.90	15 (8)	---	No
Magnesium	10 / 10	10	8,770	NU	1,910 - 18,300	NA	---	NA
Manganese	7 / 10	10	295	1.0 - 30.2	43.8 - 1,260	86 NC	---	**Yes**
Nickel	2 / 10	10	3.47	2.4 - 10	2.80 - 3.30	73 NC	100	No
Potassium	10 / 10	10	4,280	NU	1,560 - 8,720	NA	---	NA
Sodium	10 / 10	10	27,800	NU	13,100 - 66,500	NA	---	NA
Vanadium	1 / 10	10	0.685	0.60 - 2.0	0.650	26 NC	---	No
RSI Landfill - Shallow Overburden								
Volatile Organics (µg/l)								
Benzene	2 / 14	14	53.9	10	345 - 350	0.36	5	**Yes**
Chlorobenzene	1 / 14	14	4.86	10	3.0	3.9 NC	---	No
Xylenes (total)	2 / 14	14	5.89	10	9.5 - 13	1200 NC	10,000	No
Semivolatile Organics (µg/l)								
1,4-Dichlorobenzene	1 / 14	14	4.86	10	3.0	0.44	75	**Yes**
Pesticides and PCBs (µg/l)								
Aldrin	2 / 14	14	0.00160	0.003 - 0.006	0.00040 - 0.0020	0.004	---	No
beta-BHC	1 / 14	14	0.00429	0.003 - 0.004	0.040	0.037	---	**Yes**
4,4'-DDD	3 / 14	14	0.00343	0.005 - 0.010	0.0030 - 0.0070	0.28	---	No
4,4'-DDE	4 / 14	14	0.00365	0.005 - 0.006	0.00050 - 0.020	0.2	---	No
4,4'-DDT	1 / 14	14	0.00271	0.005 - 0.010	0.0010	0.2	---	No
Dieldrin	1 / 14	14	0.00266	0.005 - 0.010	0.00020	0.0042	---	No
Endosulfan II	2 / 14	14	0.00314	0.005 - 0.010	0.0020 - 0.0080	22 NC (12)	---	No
Endosulfan Sulfate	4 / 14	14	0.00293	0.005 - 0.010	0.0020 - 0.0040	22 NC (12)	---	No
Endrin	1 / 14	14	0.00266	0.005 - 0.010	0.00020	1.1 NC	2	No
Endrin Ketone	1 / 14	14	0.00307	0.006 - 0.010	0.00050	1.1 NC (14)	2 (21)	No
Heptachlor Epoxide	1 / 14	14	0.00156	0.003 - 0.006	0.00040	0.0012	0.2	No
Methoxychlor	3 / 14	14	0.0150	0.030 - 0.060	0.0070 - 0.010	18 NC	40	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
PCBs	4 / 14	14	0.0234	0.050 - 0.11	0.0060 - 0.010	0.0087 (5)	0.5	Yes
Inorganics (µg/l)								
Arsenic	12 / 14	14	39.5	11.2 - 24.2	5.50 - 186	0.045 (7)	50	Yes
Barium	14 / 14	14	39.8	NU	7.60 - 149	260 NC	2,000	No
Calcium	14 / 14	14	33,600	NU	10,400 - 83,700	NA	---	NA
Cobalt	6 / 14	14	2.35	0.50 - 3.1	1.50 - 6.60	220 NC	---	No
Copper	2 / 14	14	1.83	1.7 - 3.9	3.90 - 5.90	150 NC	---	No
Iron	14 / 14	14	16,000	NU	30.4 - 82,000	NA (6)	---	NA
Lead	3 / 14	14	1.90	1.6 - 3.2	2.0 - 8.80	15 (8)	---	No
Magnesium	14 / 14	14	5,500	NU	1,460 - 15,200	NA	---	NA
Manganese	14 / 14	14	966	NU	11.7 - 2,440	86 NC	---	Yes
Nickel	2 / 14	14	3.60	2.4 - 10	2.50 - 3.60	73 NC	100	No
Potassium	14 / 14	14	7,690	NU	2,500 - 21,100	NA	---	NA
Selenium	2 / 14	14	2.44	3.4 - 5.0	4.15 - 5.60	18 NC	50	No
Sodium	14 / 14	14	83,600	NU	11,500 - 279,000	NA	---	NA
Vanadium	5 / 14	14	1.20	0.60 - 2.0	0.720 - 3.60	26 NC	---	No
Zinc	1 / 14	14	5.65	1.2 - 73.4	3.95	1100 NC	---	No
RSI Landfill - Deep Overburden								
Volatile Organics (µg/l)								
1,2-Dichloroethene(total)	2 / 10	10	5.20	10	4.0 - 8.0	5.5 NC	70 (20)	Yes
1,1,2,2-Tetrachloroethane	1 / 10	10	5.0	10	5.0	0.052	---	Yes
Trichloroethene	2 / 10	10	8.40	10	21 - 23	1.6	5	Yes
Semi-volatile Organics (µg/l)								
Bis(2-ethylhexyl)phthalate	1 / 10	10	4.90	10	4.0	4.8	---	No
Pesticides and PCBs (µg/l)								
Aldrin	1 / 10	10	0.00160	0.003 - 0.004	0.0020	0.004	---	No
alpha-BHC	1 / 10	10	0.00155	0.003	0.0020	0.011	---	No
delta-BHC	2 / 10	10	0.00151	0.003 - 0.004	0.00060 - 0.0020	0.011 (13)	---	No
gamma-BHC(Lindane)	1 / 10	10	0.00170	0.003 - 0.004	0.0030	0.052	0.2	No
4,4'-DDE	5 / 10	10	0.00246	0.005 - 0.006	0.00060 - 0.0035	0.2	---	No
4,4'-DDT	1 / 10	10	0.00265	0.005 - 0.006	0.0020	0.2	---	No
Dieldrin	3 / 10	10	0.00218	0.005 - 0.006	0.00050 - 0.0010	0.0042	---	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Endosulfan II	1 / 10	10	0.00350	0.005 - 0.006	0.010	22 NC (12)	---	No
Endosulfan Sulfate	4 / 10	10	0.00257	0.005 - 0.006	0.00020 - 0.0040	22 NC (12)	---	No
Endrin	1 / 10	10	0.00255	0.005 - 0.006	0.0010	1.1 NC	2	No
Heptachlor Epoxide	2 / 10	10	0.00130	0.003 - 0.004	0.00020 - 0.00030	0.0012	0.2	No
PCBs	4 / 10	10	0.0307	0.050 - 0.060	0.0060 - 0.080	0.0087 (5)	0.5	**Yes**
Inorganics (μg/l)								
Aluminum	1 / 10	10	59.3	25 - 179	210	NA (6)	---	NA
Arsenic	7 / 10	10	68.5	8.0 - 21.2	3.10 - 345	0.045 (7)	50	**Yes**
Barium	10 / 10	10	115	NU	21.7 - 419	260 NC	2,000	**Yes**
Cadmium	1 / 10	10	0.800	0.50 - 2.0	2.0	1.8 NC	5	**Yes**
Calcium	10 / 10	10	116,000	NU	18,400 - 410,000	NA	---	NA
Chromium	1 / 10	10	3.27	0.70 - 5.0	20.6	18 NC (9)	100 (18)	**Yes**
Cobalt	5 / 10	10	4.49	0.50 - 2.1	2.30 - 12.2	220 NC	---	No
Copper	1 / 10	10	4.59	1.0 - 3.5	34.7	150 NC	---	No
Cyanide	2 / 7	7	35.6	10	16.5 - 208	73 NC	200	**Yes**
Iron	10 / 10	10	13,200	NU	33.0 - 63,600	NA (6)	---	NA
Lead	2 / 10	10	4.10	1.6 - 3.0	6.70 - 25.2	15 (8)	---	**Yes**
Magnesium	10 / 10	10	15,500	NU	2,620 - 49,000	NA	---	NA
Manganese	10 / 10	10	2,770	NU	1,100 - 6,400	86 NC	---	**Yes**
Nickel	2 / 10	10	4.58	2.4 - 10	3.80 - 14.2	73 NC	100	No
Potassium	10 / 10	10	22,900	NU	3,040 - 82,300	NA	---	NA
Sodium	10 / 10	10	848,000	NU	33,100 - 4,500,000	NA	---	NA
Thallium	2 / 10	10	3.89	3.6 - 8.0	8.90 - 9.0	0.29 NC (15)	2	**Yes**
Vanadium	2 / 10	10	0.965	0.60 - 2.0	1.10 - 2.65	26 NC	---	No
Zinc	1 / 10	10	7.44	4.0 - 29.7	35.4	1100 NC	---	No
RSI Landfill - Bedrock								
Volatile Organics (μg/l)								
Chlorobenzene	1 / 10	10	4.80	10	3.0	3.9 NC	---	No
1,1-Dichloroethane	1 / 10	10	4.70	10	2.0	81 NC	---	No
1,2-Dichloroethane	5 / 10	10	4.45	10	2.0 - 6.0	0.12	5	**Yes**
1,1-Dichloroethene	1 / 10	10	4.70	10	2.0	0.044	7	**Yes**
Tetrachloroethene	2 / 10	10	4.60	10	3.0	1.1	5	**Yes**

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
1,1,1-Trichloroethane	1 / 10	10	4.80	10	3.0	130 NC	200	No
Trichloroethene	4 / 10	10	4.60	10	3.0 - 5.0	1.6	5	**Yes**
Pesticides and PCBs (µg/l)								
delta-BHC	2 / 10	10	0.00147	0.003 - 0.004	0.00040 - 0.00080	0.011 (13)	---	No
gamma-Chlordane	1 / 10	10	0.00155	0.003 - 0.004	0.00050	0.052 (11)	2 (19)	No
4,4'-DDE	2 / 10	10	0.00232	0.005 - 0.006	0.00070 - 0.0010	0.2	---	No
Endosulfan Sulfate	2 / 10	10	0.00224	0.005 - 0.006	0.00060 - 0.00080	22 NC (12)	---	No
Endrin Aldehyde	1 / 10	10	0.00381	0.008 - 0.009	0.00060	1.1 NC (14)	2 (21)	No
Heptachlor Epoxide	1 / 10	10	0.00170	0.003 - 0.004	0.0020	0.0012	0.2	**Yes**
PCBs	1 / 10	10	0.0320	0.050 - 0.060	0.080	0.0087 (5)	0.5	**Yes**
Inorganics (µg/l)								
Arsenic	4 / 10	10	5.28	2.7 - 13.2	2.13 - 11.9	0.045 (7)	50	**Yes**
Barium	6 / 10	10	21.4	3.6 - 5.2	7.50 - 81.5	260 NC	2,000	No
Calcium	10 / 10	10	415,000	NU	45,100 - 1,860,000	NA	---	NA
Chromium	1 / 10	10	1.53	0.70 - 5.0	0.825	18 NC (9)	100 (18)	No
Cobalt	1 / 10	10	0.722	0.50 - 2.0	0.530	220 NC	---	No
Copper	1 / 10	10	1.35	0.50 - 3.0	4.10	150 NC	---	No
Cyanide	2 / 7	7	46.5	10	112 - 189	73 NC	200	**Yes**
Iron	4 / 10	10	243	17.3 - 78.7	117 - 1,100	NA (6)	---	NA
Lead	1 / 10	10	1.31	1.6 - 3.0	3.10	15 (8)	---	No
Magnesium	10 / 10	10	37,400	NU	4,010 - 193,500	NA	---	NA
Manganese	8 / 10	10	589	3.9 - 5.0	10.4 - 2,690	86 NC	---	**Yes**
Potassium	10 / 10	10	11,400	NU	1,920 - 44,200	NA	---	NA
Silver	2 / 10	10	6.04	0.60 - 3.0	25.8 - 27.4	18 NC	---	**Yes**
Sodium	10 / 10	10	314,000	NU	8,230 - 1,640,000	NA	---	NA
B&M Locomotive Shop Disposal Area - Shallow Overburden								
Volatile Organics (µg/l)								
1,2-Dichloroethane	1 / 8	8	4.75	10.0	3.0	0.12	5	**Yes**
4-Methyl-2-pentanone	1 / 8	8	6.37	10.0	16	290 NC	---	No
1,1,2,2-Tetrachloroethane	1 / 8	8	4.75	10.0	3.0	0.052	---	**Yes**
Pesticides and PCBs (µg/l)								
delta-BHC	1 / 8	8	0.00144	0.003	0.0010	0.011 (13)	---	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
alpha-Chlordane	1 / 8	8	0.00136	0.003	0.00040	0.052 (11)	2 (19)	No
gamma-Chlordane	1 / 8	8	0.00136	0.003	0.00040	0.052 (11)	2 (19)	No
Endosulfan I	1 / 8	8	0.00169	0.003	0.0030	22 NC (12)	---	No
Endosulfan II	1 / 8	8	0.00275	0.005 - 0.006	0.0040	22 NC (12)	---	No
Heptachlor Epoxide	1 / 8	8	0.00169	0.003	0.0030	0.0012	0.2	Yes
PCBs	1 / 8	8	0.0235	0.050 - 0.060	0.0080	0.0087 (5)	0.5	No
Inorganics (µg/l)								
Arsenic	1 / 8	8	3.04	2.7 - 8.0	4.30	0.045 (7)	50	Yes
Barium	6 / 8	8	44.7	6.4 - 38.5	33.8 - 100	260 NC	2,000	No
Calcium	8 / 8	8	50,000	NU	12,700 - 152,000	NA	---	NA
Cobalt	5 / 8	8	10.5	0.50 - 2.0	2.50 - 55.3	220 NC	---	No
Copper	2 / 8	8	3.02	0.50 - 4.1	7.0 - 8.70	150 NC	---	No
Iron	5 / 8	8	1,480	9.7 - 44	1,500 - 3,890	NA (6)	---	NA
Lead	1 / 8	8	1.65	1.6 - 4.4	3.80	15 (8)	---	No
Magnesium	8 / 8	8	8,490	NU	1,050 - 30,100	NA	---	NA
Manganese	7 / 8	8	2,295	38.7	10.5 - 11,000	86 NC	---	Yes
Nickel	3 / 8	8	5.75	2.4 - 10	2.80 - 14.7	73 NC	100	No
Potassium	8 / 8	8	4,160	NU	771 - 9,490	NA	---	NA
Sodium	8 / 8	8	17,200	NU	3,140 - 37,400	NA	---	NA
Zinc	4 / 8	8	36.5	1.2 - 9.0	15.1 - 136	1100 NC	---	No
B&M Locomotive Shop Disposal Area - Deep Overburden								
Volatile Organics (µg/l)								
Toluene	2 / 8	8	5.38	10	4.0 - 9.0	75 NC	1,000	No
Pesticides and PCBs (µg/l)								
4,4'-DDT	1 / 8	8	0.00263	0.005 - 0.006	0.0020	0.2	---	No
Endosulfan I	1 / 8	8	0.00145	0.003 - 0.004	0.00060	22 NC (12)	---	No
Endosulfan Sulfate	1 / 8	8	0.00281	0.005 - 0.006	0.0040	22 NC (12)	---	No
PCBs	2 / 8	8	0.0226	0.050 - 0.060	0.0070 - 0.0090	0.0087 (5)	0.5	Yes
Inorganics (µg/l)								
Aluminum	1 / 8	8	147	25 - 324	841	NA (6)	---	NA
Arsenic	2 / 8	8	5.56	2.7 - 8.0	11.8 - 16.6	0.045 (7)	50	Yes
Barium	5 / 8	8	21.2	3.3 - 32.3	5.90 - 53.7	260 NC	2,000	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Calcium	8 / 8	8	39,800	NU	15,300 - 90,500	NA	---	NA
Chromium	1 / 8	8	1.51	0.70 - 5.0	1.0	18 NC (9)	100 (18)	No
Cobalt	3 / 8	8	2.91	0.50 - 2.5	0.860 - 15.4	220 NC	---	No
Copper	2 / 8	8	6.12	0.50 - 4.7	10.2 - 31.1	150 NC	---	No
Iron	4 / 8	8	57.6	13.7 - 30	44.2 - 196	NA (6)	---	NA
Lead	1 / 8	8	1.55	1.6 - 3.0	4.70	15 (8)	---	No
Magnesium	7 / 8	8	6,590	124	137 - 21,900	NA	---	NA
Manganese	3 / 8	8	160	0.68 - 37.1	4.80 - 829	86 NC	---	**Yes**
Mercury	1 / 8	8	0.154	0.20	0.530	1.1 NC (16)	2	No
Nickel	3 / 8	8	5.46	2.4 - 10	3.40 - 18.3	73 NC	100	No
Potassium	8 / 8	8	4,860	NU	1,560 - 9,970	NA	---	NA
Sodium	8 / 8	8	23,300	NU	12,500 - 46,400	NA	---	NA
Vanadium	2 / 8	8	6.49	0.60 - 2.0	23.7 - 24.3	26 NC	---	No
Zinc	4 / 8	8	36.0	1.2 - 6.9	4.10 - 261	1100 NC	---	No
B&M Locomotive Shop Disposal Area - Bedrock								
Pesticides and PCBs (μg/l)								
Endosulfan Sulfate	1 / 6	6	0.00258	0.005 - 0.006	0.0010	22 NC (12)	---	No
Heptachlor Epoxide	1 / 6	6	0.00142	0.003	0.0010	0.0012	0.2	No
PCBs	2 / 6	6	0.0212	0.050 - 0.060	0.0070 - 0.010	0.0087 (5)	0.5	**Yes**
Inorganics (μg/l)								
Arsenic	1 / 6	6	3.30	2.7 - 8.0	5.10	0.045 (7)	50	**Yes**
Barium	5 / 6	6	14.1	1.50	1.40 - 25.9	260 NC	2,000	No
Calcium	6 / 6	6	24,700	NU	7,530 - 68,000	NA	---	NA
Cobalt	1 / 6	6	0.900	0.50 - 2.0	1.90	220 NC	---	No
Copper	2 / 6	6	2.23	0.50 - 3.0	4.40 - 5.10	150 NC	---	No
Iron	4 / 6	6	90.9	30	19.9 - 264	NA (6)	---	NA
Lead	2 / 6	6	1.48	1.6 - 3.0	1.90 - 2.40	15 (8)	---	No
Magnesium	6 / 6	6	6,710	NU	1,370 - 20,000	NA	---	NA
Manganese	6 / 6	6	270	NU	64.0 - 519	86 NC	---	**Yes**
Nickel	1 / 6	6	3.57	2.4 - 10	4.0	73 NC	100	No
Potassium	6 / 6	6	3,590	NU	1,310 - 7,450	NA	---	NA
Sodium	6 / 6	6	48,000	NU	8,810 - 176,000	NA	---	NA

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Zinc	1 / 6	6	3.17	1.2 - 10.7	6.40	1100 NC	---	No
Old B&M Oil/Sludge Recycling Area - Shallow Overburden								
Volatile Organics (μg/l)								
Chlorobenzene	1 / 12	12	4.83	10	3.0	3.9 NC	---	No
1,1,1-Trichloroethane	2 / 12	12	5.75	10	7.0 - 12	130 NC	200	No
Semivolatile Organics (μg/l)								
Bis(2-ethylhexyl)phthalate	2 / 12	12	4.83	10	3.0 - 5.0	4.8	---	**Yes**
Pesticides and PCBs (μg/l)								
alpha-BHC	1 / 12	12	0.00171	0.003 - 0.006	0.0020	0.011	---	No
delta-BHC	1 / 12	12	0.00171	0.003 - 0.006	0.0020	0.011 (13)	---	No
gamma-Chlordane	1 / 12	12	0.00163	0.003 - 0.006	0.0010	0.052 (11)	2 (19)	No
4,4'-DDD	2 / 12	12	0.00254	0.005 - 0.010	0.00070 - 0.00080	0.28	---	No
4,4'-DDE	2 / 12	12	0.00312	0.005 - 0.010	0.0030 - 0.0050	0.2	---	No
4,4'-DDT	1 / 12	12	0.00271	0.005 - 0.010	0.0010	0.2	---	No
Dieldrin	1 / 12	12	0.0027	0.005 - 0.010	0.00040	0.0042	---	No
Endosulfan Sulfate	1 / 12	12	0.00271	0.005 - 0.010	0.0010	22 NC (12)	---	No
PCBs	3 / 12	12	0.0242	0.050 - 0.060	0.010 - 0.020	0.0087 (5)	0.5	**Yes**
Inorganics (μg/l)								
Arsenic	4 / 12	12	7.43	2.7 - 9.7	9.90 - 27.1	0.045 (7)	50	**Yes**
Barium	8 / 12	12	17.4	5.8 - 7.0	9.80 - 45.6	260 NC	2,000	No
Cadmium	1 / 12	12	0.650	0.50 - 2.0	0.545	1.8 NC	5	No
Calcium	12 / 12	12	17,500	NU	7,840 - 58,600	NA	---	NA
Cobalt	4 / 12	12	2.89	0.50 - 2.8	3.90 - 14.7	220 NC	---	No
Copper	1 / 12	12	2.19	0.50 - 3.0	15.3	150 NC	---	No
Iron	11 / 12	12	8,050	30	10.2 - 23,500	NA (6)	---	NA
Lead	2 / 12	12	1.43	1.6 - 3.0	2.30 - 3.30	15 (8)	---	No
Magnesium	12 / 12	12	3,250	NU	1,480 - 9,640	NA	---	NA
Manganese	12 / 12	12	541	NU	56.4 - 1,480	86 NC	---	**Yes**
Mercury	1 / 12	12	0.122	0.20	0.370	1.1 NC (16)	2	No
Nickel	2 / 12	12	3.77	2.4 - 10	5.0 - 5.40	73 NC	100	No
Potassium	12 / 12	12	2,410	NU	1,085 - 5,560	NA	---	NA
Sodium	12 / 12	12	10,800	NU	2,440 - 23,000	NA	---	NA

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Vanadium	1 / 12	12	0.870	0.60 - 2.8	1.50	26 NC	---	No
Zinc	2 / 12	12	34.4	1.2 - 10	104 - 288	1100 NC	---	No
Old B&M Oil/Sludge Recycling Area - Deep Overburden								
Volatile Organics (µg/l)								
Carbon Disulfide	1 / 12	12	5.0	10	5.0	100 NC	---	No
1,1-Dichloroethane	2 / 12	12	4.67	10	3.0	81 NC	---	No
1,1,1-Trichloroethane	2 / 12	12	5.0	10	4.0 - 6.0	130 NC	200	No
Pesticides and PCBs (µg/l)								
delta-BHC	1 / 12	12	0.00154	0.003	0.0020	0.011 (13)	---	No
4,4'-DDD	1 / 12	12	0.00259	0.005 - 0.006	0.00060	0.28	---	No
4,4'-DDE	2 / 12	12	0.00257	0.005 - 0.006	0.00030 - 0.0030	0.2	---	No
Endosulfan Sulfate	1 / 12	12	0.00260	0.005 - 0.006	0.00070	22 NC (12)	---	No
Endrin	1 / 12	12	0.00257	0.005 - 0.006	0.00080	1.1 NC	2	No
Endrin Aldehyde	1 / 12	12	0.00403	0.008 - 0.009	0.00090	1.1 NC (14)	2 (21)	No
Heptachlor Epoxide	2 / 12	12	0.00151	0.003 - 0.004	0.00060 - 0.0020	0.0012	0.2	Yes
Inorganics (µg/l)								
Arsenic	1 / 12	12	3.60	2.7 - 11.1	7.40	0.045 (7)	50	Yes
Barium	9 / 12	12	17.3	5.2 - 17.4	11.8 - 31.7	260 NC	2,000	No
Calcium	12 / 12	12	20,700	NU	11,400 - 28,400	NA	---	NA
Chromium	1 / 12	12	1.79	0.70 - 5.0	4.70	18 NC (9)	100 (18)	No
Cobalt	1 / 12	12	1.42	0.62 - 2.0	8.10	220 NC	---	No
Iron	6 / 12	12	561	9.7 - 44.4	15.1 - 6,050	NA (6)	---	NA
Magnesium	12 / 12	12	3,860	NU	1,860 - 7,170	NA	---	NA
Manganese	12 / 12	12	455	NU	10.2 - 1,370	86 NC	---	Yes
Mercury	2 / 12	12	0.120	0.20	0.220	1.1 NC (16)	2	No
Nickel	1 / 12	12	3.33	2.4 - 10	3.90	73 NC	100	No
Potassium	12 / 12	12	2,540	NU	1,420 - 3,700	NA	---	NA
Sodium	12 / 12	12	14,500	NU	3,590 - 30,700	NA	---	NA
Vanadium	2 / 12	12	0.776	0.60 - 2.0	0.590 - 2.10	26 NC	---	No
Old B&M Oil/Sludge Recycling Area - Bedrock								
Volatile Organics (µg/l)								
Chloroform	1 / 10	10	4.80	10	3.0	0.15	60	Yes

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
1,1-Dichloroethane	2 / 10	10	4.70	10	3.0 - 4.0	81 NC	---	No
Pesticides and PCBs (µg/l)								
4,4'-DDD	1 / 10	10	0.00239	0.005 - 0.006	0.00040	0.28	---	No
Inorganics (µg/l)								
Aluminum	1 / 10	10	125	28.7 - 380	649	NA (6)	---	NA
Arsenic	4 / 10	10	4.23	2.7 - 8.7	3.0 - 9.60	0.045 (7)	50	**Yes**
Barium	6 / 10	10	32.2	5.1 - 7.5	16.4 - 122	260 NC	2,000	No
Calcium	10 / 10	10	37,500	NU	11,000 - 120,000	NA	---	NA
Cobalt	2 / 10	10	1.55	0.50 - 2.0	4.60 - 5.60	220 NC	---	No
Copper	2 / 10	10	11.1	0.50 - 3.0	42.2 - 60.9	150 NC	---	No
Iron	9 / 10	10	734	30	22.0 - 4,770	NA (6)	---	NA
Lead	2 / 10	10	1.93	1.6 - 3.0	2.80 - 7.30	15 (8)	---	No
Magnesium	10 / 10	10	6,580	NU	1,070 - 23,100	NA	---	NA
Manganese	10 / 10	10	334	NU	10.2 - 1,370	86 NC	---	**Yes**
Nickel	3 / 10	10	14.5	2.4 - 10	2.50 - 112	73 NC	100	**Yes**
Potassium	10 / 10	10	4,750	NU	1,210 - 16,700	NA	---	NA
Sodium	10 / 10	10	37,300	NU	10,000 - 134,000	NA	---	NA
Vanadium	1 / 10	10	0.835	0.60 - 2.0	1.10	26 NC	---	No
Zinc	2 / 10	10	9.28	1.2 - 14.1	30.4 - 44.9	1100 NC	---	No
Asbestos Lagoons - Shallow Overburden								
Volatile Organics (µg/l)								
1,1-Dichloroethane	2 / 10	10	4.50	10	2.0 - 3.0	81 NC	---	No
4-Methyl-2-pentanone	1 / 10	10	5.60	10	11	290 NC	---	No
1,1,2,2-Tetrachloroethane	1 / 10	10	4.80	10	3.0	0.052	---	**Yes**
Semivolatile Organics (µg/l)								
Bis(2-ethylhexyl)phthalate	1 / 10	10	4.80	10	3.0	4.8	---	No
2-Methylnaphthalene	2 / 10	10	4.70	10	3.0 - 4.0	110 NC (10)	---	No
Naphthalene	1 / 10	10	4.80	10	3.0	150	---	No
Pesticides and PCBs (µg/l)								
4,4'-DDE	1 / 10	10	0.00260	0.005 - 0.006	0.0020	0.2	---	No
Dieldrin	1 / 10	10	0.00238	0.005 - 0.006	0.00030	0.0042	---	No
Heptachlor Epoxide	1 / 10	10	0.00145	0.003 - 0.004	0.00050	0.0012	0.2	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Inorganics (µg/l)								
Aluminum	2 / 10	10	281	25.3 - 136	1,010 - 1,500	NA	---	No
Arsenic	6 / 10	10	18.4	2.7 - 8.0	12.1 - 58.1	0.045 (7)	50	**Yes**
Barium	9 / 10	10	24.4	6.3	6.40 - 62.0	260 NC	2,000	No
Calcium	10 / 10	10	15,900	NU	3,160 - 43,200	NA	---	NA
Chromium	2 / 10	10	2.53	0.70 - 5.0	6.80 - 8.20	18 NC (9)	100 (18)	No
Cobalt	5 / 10	10	1.84	0.50 - 2.0	1.60 - 3.90	220 NC	---	No
Copper	1 / 10	10	3.20	0.50 - 3.0	22.4	150 NC	---	No
Iron	9 / 10	10	5,130	12.3	63.2 - 17,600	NA (6)	---	NA
Lead	3 / 10	10	7.70	1.6 - 3.0	2.0 - 63.6	15 (8)	---	**Yes**
Magnesium	9 / 10	10	1,280	226	495 - 2,450	NA	---	NA
Manganese	9 / 10	10	516	2.40	5.60 - 1,020	86 NC	---	**Yes**
Nickel	2 / 10	10	4.10	2.4 - 10	2.40 - 10.0	73 NC	100	No
Potassium	10 / 10	10	2,900	NU	389 - 8,380	NA	---	NA
Silver	1 / 9	9	0.883	0.60 - 3.0	0.750	18 NC	---	No
Sodium	10 / 10	10	17,000	NU	1,370 - 42,000	NA	---	NA
Vanadium	2 / 10	10	0.810	0.60 - 2.0	1.0 - 1.20	26 NC	---	No
Zinc	3 / 10	10	25.3	1.2 - 4.0	39.5 - 141	1100 NC	---	No
Asbestos Lagoons - Deep Overburden								
Volatile Organics (µg/l)								
1,1-Dichloroethane	5 / 8	8	5.25	10	2.0 - 10	81 NC	---	No
1,2-Dichloroethane	2 / 8	8	4.50	10	3.0	0.12	5	**Yes**
Semivolatile Organics (µg/l)								
Bis(2-ethylhexyl)phthalate	2 / 8	8	5.75	10	3.0 - 13	4.8	---	**Yes**
Pesticides and PCBs (µg/l)								
Aldrin	2 / 8	8	0.00143	0.003	0.00040 - 0.0020	0.004	---	No
delta-BHC	3 / 8	8	0.00181	0.003	0.0010 - 0.0040	0.011 (13)	---	No
gamma-Chlordane	2 / 8	8	0.00127	0.003	0.00050 - 0.00070	0.052 (11)	2 (19)	No
4,4'-DDD	1 / 8	8	0.00242	0.005 - 0.006	0.00090	0.28	---	No
4,4'-DDE	1 / 8	8	0.00248	0.005 - 0.006	0.00080	0.2	---	No
Dieldrin	1 / 8	8	0.00241	0.005 - 0.006	0.00080	0.0042	---	No
Endosulfan I	1 / 8	8	0.00141	0.003	0.00080	22 NC (12)	---	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
Endosulfan Sulfate	2 / 8	8	0.00261	0.005 - 0.007	0.00040 - 0.0030	22 NC (12)	---	No
Endrin	1 / 8	8	0.00256	0.005 - 0.006	0.0020	1.1 NC	2	No
Endrin Ketone	1 / 8	8	0.00289	0.006 - 0.007	0.00060	1.1 NC (14)	2 (21)	No
Heptachlor Epoxide	3 / 8	8	0.00231	0.003	0.0020 - 0.0050	0.0012	0.2	**Yes**
PCBs	1 / 8	8	0.0241	0.050 - 0.060	0.0080	0.0087 (5)	0.5	No
Inorganics (μg/l)								
Aluminum	2 / 8	8	662	25 - 154	2,460 - 2,625	NA (6)	---	NA
Arsenic	2 / 8	8	5.67	2.7 - 8.0	12.0 - 17.3	0.045 (7)	50	**Yes**
Barium	8 / 8	8	81.9	NU	53.3 - 159	260 NC	2,000	No
Beryllium	1 / 8	8	0.634	0.10 - 1.7	2.40	0.016	4	**Yes**
Cadmium	1 / 8	8	0.750	0.50 - 2.0	1.25	1.8 NC	5	No
Calcium	8 / 8	8	38,400	NU	19,300 - 57,400	NA	---	NA
Chromium	1 / 8	8	1.58	0.70 - 5.0	1.40	18 NC (9)	100 (18)	No
Cobalt	7 / 8	8	22.9	2.0	0.700 - 54.7	220 NC	---	No
Copper	2 / 8	8	2.83	0.81 - 3.0	7.0 - 8.70	150 NC	---	No
Iron	7 / 8	8	2,030	30	55.8 - 6,780	NA (6)	---	NA
Lead	1 / 8	8	1.25	1.6 - 3.0	1.60	15 (8)	---	No
Magnesium	8 / 8	8	7,750	NU	4,610 - 11,400	NA	---	NA
Manganese	8 / 8	8	2,410	NU	853 - 4,160	86 NC	---	**Yes**
Nickel	5 / 8	8	18.0	2.4 - 10	8.40 - 49.9	73 NC	100	No
Potassium	8 / 8	8	7,070	NU	2,370 - 18,450	NA	---	NA
Sodium	8 / 8	8	108,000	NU	28,500 - 292,500	NA	---	NA
Zinc	3 / 8	8	29.0	1.2 - 4.0	6.0 - 113	1100 NC	---	No
Asbestos Lagoons - Bedrock								
Volatile Organics (μg/l)								
1,1-Dichloroethane	2 / 6	6	6.42	10.0	9.0 - 9.5	81 NC	---	No
1,2-Dichloroethane	6 / 6	6	15.4	NU	3.0 - 39	0.12	5	**Yes**
Semivolatile Organics (μg/l)								
Bis(2-ethylhexyl)phthalate	1 / 6	6	7.0	10.0	17	4.8	---	**Yes**
1,2-Dichlorobenzene	1 / 6	6	4.50	10.0	2.0	27 NC	---	No
Pesticides and PCBs (μg/l)								
delta-BHC	1 / 6	6	0.00175	0.003 - 0.004	0.0020	0.011 (13)	---	No

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean (3)	Range of Sample Quantitation Limits	Range of Detected Concentrations	Residential Tap Water RBC (4)	Maximum Contaminant Level (17)	Maximum Detect > RBC?
alpha-Chlordane	1 / 6	6	0.00158	0.003 - 0.004	0.0010	0.052 (11)	2 (19)	No
gamma-Chlordane	1 / 6	6	0.00148	0.003 - 0.004	0.00040	0.052 (11)	2 (19)	No
4,4'-DDD	1 / 6	6	0.00232	0.005 - 0.006	0.00040	0.28	---	No
4,4'-DDE	1 / 6	6	0.00308	0.005 - 0.006	0.0050	0.2	---	No
Endosulfan II	1 / 6	6	0.00275	0.005 - 0.006	0.0030	22 NC (12)	---	No
Endosulfan Sulfate	1 / 6	6	0.00267	0.005 - 0.008	0.00050	22 NC (12)	---	No
Heptachlor Epoxide	1 / 6	6	0.00225	0.003 - 0.004	0.0050	0.0012	0.2	**Yes**
PCBs	1 / 6	6	0.0617	0.10 - 0.12	0.10	0.0087 (5)	0.5	**Yes**
Inorganics (µg/l)								
Aluminum	2 / 6	6	611	25 - 82.2	1,600 - 1,965	NA (6)	---	NA
Barium	5 / 6	6	36.1	37.3	35.7 - 43.4	260 NC	2,000	No
Beryllium	1 / 6	6	0.700	0.10 - 2.0	2.10	0.016	4	**Yes**
Cadmium	1 / 6	6	0.925	0.50 - 2.0	2.05	1.8 NC	5	**Yes**
Calcium	6 / 6	6	73,000	NU	43,400 - 122,000	NA	---	NA
Cobalt	3 / 6	6	40.1	0.50 - 2.0	0.600 - 135	220 NC	---	No
Copper	2 / 6	6	4.51	1.6 - 3.0	7.90 - 14.6	150 NC	---	No
Iron	6 / 6	6	579	NU	390 - 805	NA (6)	---	NA
Lead	3 / 6	6	4.76	1.6 - 3.0	1.70 - 21.0	15 (8)	---	**Yes**
Magnesium	6 / 6	6	18,200	NU	8,490 - 24,350	NA	---	NA
Manganese	6 / 6	6	3,200	NU	453 - 8,745	86 NC	---	**Yes**
Nickel	2 / 6	6	38.8	2.4 - 10	99.1 - 122	73	100	**Yes**
Potassium	6 / 6	6	7,230	NU	3,820 - 10,800	NA	---	NA
Silver	1 / 6	6	0.955	0.60 - 3.0	0.630	18 NC	---	No
Sodium	6 / 6	6	61,900	NU	17,700 - 148,000	NA	---	NA
Zinc	2 / 6	6	53.0	1.2 - 4.0	147 - 166	1100 NC	---	No

NOTES:

1. The number of samples in which the contaminant was detected divided by the total number of samples analyzed, excluding rejected samples.
2. The number of samples used in calculating the mean.
3. The arithmetic mean was calculated using the detected concentrations and one-half the detection limit for non-detect samples. In some cases, high detection limits resulted in the calculation of arithmetic means above maximum detected concentrations.
4. EPA Region III residential tap water RBCs were used. RBCs for noncarcinogenic chemicals are based on a hazard quotient of 0.1, following EPA Region I guidance. Therefore, the RBCs reported by Region III were divided by 10 for these noncarcinogenic chemicals.

TABLE 6-8(Continued). SUMMARY OF CHEMICALS DETECTED IN GROUNDWATER AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH

NOTES (continued):

5. The RBC for carcinogenic PCBs was used.
6. The RBC is based on provisional toxicity criteria and were not used since Region I does not concur with the use of this value in a risk assessment.
7. The RBC for arsenic as a carcinogen was used.
8. Because no tap water RBC exists for lead, a drinking water lead concentration of 15 ug/l was used. This drinking water criterion is protective of blood lead levels in children (U.S. EPA, 1991c).
9. The RBC for chromium VI was used.
10. The RBC for pyrene was used for noncarcinogenic PAHs that lack RBCs.
11. The RBC for chlordane was used.
12. The RBC for endosulfan was used.
13. The RBC for alpha-BHC was used.
14. The RBC for endrin was used.
15. The RBC for thallium carbonate, thallium chloride or thallium sulfate was used.
16. The RBC for inorganic mercury was used.
17. Value is a lifetime health advisory; the concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects over a lifetime of exposure, with a margin of safety.
18. MCL is for total chromium.
19. MCL is for chlordane.
20. MCL is for cis-1,2-dichloroethene.
21. MCL is for endrin.

NU = Not used; chemical was detected in all samples.
PCBs = Polychlorinated Biphenyls, or Aroclors.
RBC = Risk-based concentration.
NA = Not applicable. RBCs are not available for calcium, magnesium, potassium, and sodium.
--- = Not Available; drinking water standard and helath advisory not available for chemical.
Yes = The maximum detected concentration of this chemical was detected above the residential tap water RBC, therefore the chemical was selected as a chemical of potential concern (COPC). COPCs were not selected in background data.
No = This chemical was detected below residential tap water RBCs, therefore the chemical was eliminated as a chemical of potential concern.

TABLE 6-9. COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF COPC IN SURFACE SOIL TO INDUSTRIAL SOIL RBCs

Analyte	Arithmetic Mean	Maximum Detected Concentration	Industrial Soil RBC (1)	Maximum Detect > RBC?
Background				
Inorganics (mg/kg)				
Aluminum	7,880	9,630	100,000 NC	No
Arsenic	5.70	7.60	3.8 (2)	**Yes**
Iron	6,670	8,350	61,000 NC	No
Manganese	142	206	1,000 NC	No
B&M Railroad Landfill				
Semivolatile Organics (μg/kg)				
Benzo(a)anthracene	3,540	16,000	7,800	**Yes**
Benzo(a)pyrene	3,590	18,000	780	**Yes**
Benzo(b)fluoranthene	8,210	33,000	7,800	**Yes**
Dibenzo(a,h)anthracene	1,610	4,200	780	**Yes**
Indeno(1,2,3-cd)pyrene	2,030	10,000	7,800	**Yes**
Inorganics (mg/kg)				
Antimony	16.9	155	82 NC	**Yes**
Arsenic	18.7	36.0	3.8 (2)	**Yes**
Barium	258	922	14,000 NC	No
Cadmium	7.59	34.8	100 NC	No
Chromium	73.9	304	1,000 NC (3)	No
Copper	361	1,030	8,200 NC	No
Iron	35,300	76,800	61,000 NC	**Yes**
Lead	559	1,130	1,000 (4)	**Yes**
Manganese	396	1,080	1,000 NC	**Yes**
Mercury	1.07	3.40	61.0 NC (5)	No
Zinc	1,240	4,400	61,000 NC	No
RSI Landfill				
Inorganics (mg/kg)				
Aluminum	7,180	9,470	100,000 NC	No
Arsenic	4.45	4.80	3.8 (2)	**Yes**
Iron	9,710	13,600	61,000 NC	No
Manganese	161	212	1,000 NC	No

TABLE 6-9(Continued). COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF COPC IN SURFACE SOIL TO INDUSTRIAL SOIL RBCs

Analyte	Arithmetic Mean	Maximum Detected Concentration	Industrial Soil RBC (1)	Maximum Detect > RBC?
B&M Locomotive Shop Disposal Area				
Benzo(a)anthracene	666	2,300	7,800	No
Benzo(a)pyrene	503	1,700	780	**Yes**
Benzo(b)fluoranthene	890	2,900	7,800	No
Dibenzo(a,h)anthracene	226	400	780	No
Indeno(1,2,3-cd)pyrene	314	920	7,800	No
Inorganics (mg/kg)				
Antimony	14.2	53.0	82 NC	No
Arsenic	17.3	49.3	3.8 (2)	**Yes**
Beryllium	0.442	0.850	1.3	No
Chromium	31.1	87.4	1,000 NC (3)	No
Copper	734	3,135	8,200 NC	No
Iron	34,800	101,350	61,000 NC	**Yes**
Lead	575	2,370	1,000 (4)	**Yes**
Manganese	322	917	1,000 NC	No
Old B&M Oil/Sludge Recycling Area				
Inorganics (mg/kg)				
Aluminum	6,300	8,640	100,000 NC	No
Antimony	3.64	14.1	82 NC	No
Arsenic	8.80	10.8	3.8 (2)	**Yes**
Beryllium	0.128	0.270	1.3	No
Iron	9,320	10,600	61,000 NC	No
Manganese	110	135	1,000 NC	No
Contaminated Soil Area				
Semivolatile Organics (μg/kg)				
Benzo(a)anthracene	1,700	18,000	7,800	**Yes**
Benzo(a)pyrene	1,640	15,000	780	**Yes**
Benzo(b)fluoranthene	2,560	28,000	7,800	**Yes**
Dibenzo(a,h)anthracene	1,300	3,300	780	**Yes**
Indeno(1,2,3-cd)pyrene	1,360	7,900	7,800	**Yes**
Pentachlorophenol	4,480	75,000	48,000	**Yes**

TABLE 6-9(Continued). COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF COPC IN SURFACE SOIL TO INDUSTRIAL SOIL RBCs

Analyte	Arithmetic Mean	Maximum Detected Concentration	Industrial Soil RBC (1)	Maximum Detect > RBC?
Pesticides and PCBs (µg/kg)				
4,4'-DDT	372	16,000	17,000	No
Inorganics (mg/kg)				
Antimony	28.2	494	82 NC	**Yes**
Arsenic	25.8	233	3.8 (2)	**Yes**
Barium	226	3,630	14,000 NC	No
Cadmium	1.17	8.0	100 NC	No
Chromium	42.8	385	1,000 NC (3)	No
Copper	1,510	46,200	8,200 NC	**Yes**
Iron	37,400	146,000	61,000 NC	**Yes**
Lead	1,310	10,800	1,000 (4)	**Yes**
Manganese	425	3,400	1,000 NC	**Yes**
Mercury	0.432	2.50	61 NC (5)	No
Nickel	32.4	329	4,100 NC	No
Zinc	443	4,170	61,000 NC	No

NOTES:

1. EPA Region III industrial soil RBCs were used for informational purposes and were not used for COPC selection. RBCs for noncarcinogenic chemicals, indicated by NC, are based on a hazard quotient of 0.1, following EPA Region I guidance. Therefore, the soil RBCs reported by Region III were divided by 10 for these noncarcinogenic chemicals.
2. The RBC for arsenic as a carcinogen was used.
3. The RBC for chromium VI was used.
4. A residential soil screening level for lead was used.
5. The RBC for inorganic mercury was used.

RBC = Risk-based concentration.

NC = Noncarcinogenic Chemicals

Yes = The maxiumum detected concentration of this chemcial was detected above the industrial soil RBC.

TABLE 6-10. COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF COPC IN SEDIMENT TO INDUSTRIAL SOIL RBCs

Analyte	Arithmetic Mean	Maximum Detected Concentration	Industrial Soil RBC (1)	Maximum Detect > RBC?
Background				
Volatile Organics (μg/kg)				
2-Hexanone	16.8	31	NA	NA
Semivolatile Organics (μg/kg)				
Benzo(a)pyrene	315	290	780	No
Inorganics (mg/kg)				
Aluminum	8,130	14,800	100,000 NC	No
Arsenic	4.0	5.20	3.8 (3)	**Yes**
Beryllium	1.47	2.70	1.3	**Yes**
Iron	4,820	6,590	61,000 NC	No
Manganese	247	469	1,000 NC	No
West Middlesex Canal Area				
Semivolatile Organics (μg/kg)				
Benzo(a)anthracene	4,080	2,600	7,800	No
Benzo(b)fluoranthene	3,870	3,600	7,800	No
Pesticides and PCBs (μg/kg)				
PCBs	256	2,000	740 (2)	**Yes**
Inorganics (mg/kg)				
Aluminum	8,150	29,400	100,000 NC	No
Arsenic	16.4	101	3.8 (3)	**Yes**
Beryllium	0.567	3.80	1.3	**Yes**
Cadmium	0.771	5.40	100 NC	No
Chromium	25.4	100	1,000 NC (4)	No
Iron	10,500	33,600	61,000 NC	No
Lead	86.9	554	1,000 (5)	No
Manganese	437	2,750	1,000 NC	**Yes**
Vanadium	24.1	110	1,400 NC	No
Central Wetlands Area				
Semivolatile Organics (μg/kg)				
Benzo(a)anthracene	2,440	40,000	7,800	**Yes**
Benzo(a)pyrene	1,530	18,000	780	**Yes**

TABLE 6-10(Continued). COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF COPC IN SEDIMENT TO INDUSTRIAL SOIL RBCs

Analyte	Arithmetic Mean	Maximum Detected Concentration	Industrial Soil RBC (1)	Maximum Detect > RBC?
Benzo(b)fluoranthene	3,100	60,000	7,800	**Yes**
Dibenzo(a,h)anthracene	1,480	140	780	No
Indeno(1,2,3-cd)pyrene	1,560	18,000	7,800	**Yes**
Pesticides and PCBs (μg/kg)				
PCBs	54.0	570	740 (2)	No
Inorganics (mg/kg)				
Aluminum	6,950	30,200	100,000 NC	No
Antimony	12.0	158	82 NC	**Yes**
Arsenic	14.9	40.8	3.8 (3)	**Yes**
Beryllium	0.620	3.70	1.3	**Yes**
Chromium	20.6	106	1,000 NC (4)	No
Copper	259	3,600	8,200 NC	No
Iron	13,600	50,200	61,000 NC	No
Lead	302	2,970	1,000 (5)	**Yes**
Manganese	322	1,230	1,000 NC	**Yes**
East Middlesex Canal and Wetlands Area				
Semivolatile Organics (μg/kg)				
Benzo(a)anthracene	3,950	21,000	7,800	**Yes**
Benzo(a)pyrene	3,620	15,000	780	**Yes**
Benzo(b)fluoranthene	3,780	19,000	7,800	**Yes**
Benzo(k)fluoranthene	3,680	12,500	78,000	No
Dibenzo(a,h)anthracene	3,160	2,950	780	**Yes**
Indeno(1,2,3-cd)pyrene	3,360	7,700	7,800	No
Pesticides and PCBs (μg/kg)				
PCBs	75.2	480	740 (2)	No
Inorganics (mg/kg)				
Aluminum	6,110	32,300	100,000 NC	No
Arsenic	19.6	256	3.8 (3)	**Yes**
Beryllium	0.417	3.20	1.3	**Yes**
Chromium	11.1	64.6	1,000 NC (4)	No
Iron	11,200	76,300	61,000 NC	**Yes**

TABLE 6-10(Continued). COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS OF COPC IN SEDIMENT TO INDUSTRIAL SOIL RBCs

Analyte	Arithmetic Mean	Maximum Detected Concentration	Industrial Soil RBC (1)	Maximum Detect > RBC?
Manganese	383	2,700	1,000 NC	Yes
Vanadium	15.6	76.4	1,400 NC	No

NOTES:

1. EPA Region III industrial soil RBCs were used for informational purposes and were not used for COPC selection. RBCs for noncarcinogenic chemicals, indicated by NC, are based on a hazard quotient of 0.1, following E Region I guidance. Therefore, the soil RBCs reported by Region III were divided by 10 for these noncarcinogenic ch
2. The RBC for carcinogenic PCBs was used.
3. The RBC for arsenic as a carcinogen was used.
4. The RBC for chromium VI was used.
5. A residential soil screening level for lead was used.

PCBs = Polychlorinated Biphenyls, or Aroclors.

RBC = Risk-based concentration.

NA = Not applicable. An RBC is not available for 2-hexanone.

Yes = The maxiumum detected concentration of this chemical was detected above the industrial soil RBC.

No = This chemical was detected below industrial soil RBCs.

TABLE 6-11. COPCS IN SURFACE SOIL

Chemical	B&M Railroad Landfill	RSI Landfill	B&M Locomotive Shop Disposal Area	Old B&M Oil/Sludge Recycling Area	Contaminated Soil Area
Antimony	X		X	X	X
Arsenic	X	X	X	X	X
Barium	X				X
Benzo(a)anthracene	X		X		X
Benzo(a)pyrene	X		X		X
Benzo(b)fluoranthene	X		X		X
Beryllium			X	X	
Cadmium	X				X
Chromium	X		X		X
Copper	X		X		X
4,4'-DDT					X
Dibenzo(a,h)anthracene	X		X		X
Indeno(1,2,3-cd)pyrene	X		X		X
Lead	X		X		X
Manganese	X	X	X		X
Mercury	X				X
Nickel					X
Pentachlorophenol					X
Zinc	X				X

TABLE 6-12. COPCS IN SEDIMENT

Chemical	West Middlesex Canal Area	Central Wetlands Area	East Middlesex Canal and Wetlands Area
Antimony		X	
Arsenic	X	X	X
Benzo(a)anthracene	X	X	X
Benzo(a)pyrene		X	X
Benzo(b)fluoranthene	X	X	X
Benzo(k)fluoranthene			X
Beryllium	X	X	X
Cadmium	X		
Chromium	X	X	X
Copper		X	
Dibenzo(a,h)anthracene		X	X
Indeno(1,2,3-cd)pyrene		X	X
Lead	X	X	
Manganese	X	X	X
PCBs	X	X	X
Vanadium	X		X

TABLE 6-13. COPCS IN SURFACE WATER

Chemical	West Middlesex Canal Area	Central Wetlands Area	East Middlesex Canal and Wetlands Area
Aldrin			X
Antimony			X
Arsenic	X	X	X
Barium		X	X
Benzene			X
Benzo(a)anthracene			X
Benzo(b)fluoranthene		X	X
Beryllium			X
δ-BHC	X		
γ-BHC			X
Cadmium		X	
Chloromethane			X
Chromium		X	X
Copper		X	X
1,4-Dichlorobenzene			X
total 1,2-Dichloroethene		X	
Heptachlor epoxide	X		
Lead		X	X
Manganese	X	X	X
Methylene chloride		X	
4-Methylphenol			X
Nickel		X	X
PCBs	X		X
Selenium			X
Silver			X
Tetrachloroethene		X	

TABLE 6-13 (Continued). COPCS IN SURFACE WATER

Chemical	West Middlesex Canal Area	Central Wetlands Area	East Middlesex Canal and Wetlands Area
Thallium	X	X	X
Trichloroethene		X	
Vanadium		X	X
Zinc		X	X

TABLE 6-14 . COPCS IN GROUNDWATER

Chemical	B&M Railroad Landfill			RSI Landfill			B&M Locomotive Shop Disposal Area			Old B&M Oil/Sludge Recycling Area			Asbestos Lagoon		
	1*	2*	3*	1	2	3	1	2	3	1	2	3	1	2	3
Aldrin	X														
Antimony	X														
Arsenic	X		X	X	X	X	X	X	X	X	X	X	X	X	
Barium	X				X										
Benzene				X											
Beryllium														X	X
β-BHC				X											
Bis(2-ethylhexyl)phthalate			X							X				X	X
Cadmium					X										X
Carbazole	X														
Chlorobenzene		X													
Chloroform			X									X			
Chromium					X										
Cyanide					X	X									
1,4-Dichlorobenzene				X											
1,2-Dichloroethane		X	X			X	X							X	X
1,1-Dichloroethene		X	X			X									
total 1,2-Dichloroethene			X		X										
Heptachlor epoxide						X	X				X			X	X

TABLE 6-14 (Continued). COPCS IN GROUNDWATER

Chemical	B&M Railroad Landfill			RSI Landfill			B&M Locomotive Shop Disposal Area			Old B&M Oil/Sludge Recycling Area			Asbestos Lagoon		
	1*	2*	3*	1	2	3	1	2	3	1	2	3	1	2	3
Lead	X				X								X		X
Manganese	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4-Methylphenol	X														
Nickel												X			X
PCBs	X	X		X	X	X		X	X	X					X
Silver						X									
1,1,2,2-Tetrachloroethane					X		X						X		
Tetrachloroethene						X									
Thallium					X										
Trichloroethene		X	X		X	X									

NOTE: 1 - Shallow Overburden; 2 - Deep Overburden; 3 - Bedrock

TABLE 6-15. EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL

Chemical	Arithmetic Mean	Maximum Detected Concentration	95% UCL	Exposure Point Concentration
B&M Railroad Landfill				
Semivolatile Organics (μg/kg)				
Benzo(a)anthracene	3,540	16,000	11,100	11,100
Benzo(a)pyrene	3,590	18,000	11,300	11,300
Benzo(b)fluoranthene	8,210	33,000	26,400	26,400
Dibenzo(a,h)anthracene	1,610	4,200	9,450	4,200 *
Indeno(1,2,3-c,d)pyrene	2,030	10,000	8,410	8,410
Inorganics (mg/kg)				
Antimony	16.9	155	23.3	23.3
Arsenic	18.7	36.0	27.0	27.0
Barium	258	922	744	744
Cadmium	7.59	34.8	74.1	34.8 *
Chromium	73.9	304	201	201
Copper	361	1,030	878	878
Lead	559	1,130	1,020	1,020
Manganese	396	1,080	609	609
Mercury	1.07	3.40	4.69	3.40 *
Zinc	1,240	4,400	9,650	4,400 *
RSI Landfill				
Inorganics (mg/kg)				
Arsenic	4.45	4.80	4.77	4.77
Manganese	161	212	197	197
B&M Locomotive Shop Disposal Area				
Semivolatile Organics (μg/kg)				
Benzo(a)anthracene	666	2,300	13,200	2,300 *
Benzo(a)pyrene	503	1,700	17,900	1,700 *
Benzo(b)fluoranthene	890	2,900	35,400	2,900 *
Dibenzo(a,h)anthracene	226	400	366	366
Indeno(1,2,3-c,d)pyrene	314	920	1,640	920 *
Inorganics (mg/kg)				
Antimony	14.2	53.0	260	53.0 *
Arsenic	17.3	49.3	135	49.3 *
Beryllium	0.442	0.850	1.22	0.850 *
Chromium	31.1	87.4	358	87.4 *

TABLE 6-15 (continued). EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN SURFACE SOIL

Chemical	Arithmetic Mean	Maximum Detected Concentration	95% UCL	Exposure Point Concentration
Copper	734	3,140	4.71E+07	3,140 *
Lead	575	2,370	8.38E+10	2,370 *
Manganese	322	917	1,830	917 *
<u>Old B&M Oil/Sludge Recycling Area</u>				
Inorganics (mg/kg)				
Antimony	3.64	14.1	15.6	14.1 *
Arsenic	8.80	10.8	10.5	10.5
Beryllium	0.128	0.270	0.199	0.199
<u>Contaminated Soil Area</u>				
Semivolatile Organics (µg/kg)				
Benzo(a)anthracene	1,700	18,000	2,530	2,530
Benzo(a)pyrene	1,640	15,000	2,530	2,530
Benzo(b)fluoranthene	2,560	28,000	3,960	3,960
Dibenzo(a,h)anthracene	1,300	3,300	1,960	1,960
Indeno(1,2,3-c,d)pyrene	1,360	7,900	2,160	2,160
Pentachlorophenol	4,480	75,000	6,310	6,310
Pesticides and PCBs (µg/kg)				
4,4'-DDT	372	16,000	84.6	84.6
Inorganics (mg/kg)				
Antimony	28.2	494	25.9	25.9
Arsenic	25.8	233	29.3	29.3
Barium	226	3,630	228	228
Cadmium	1.17	8.00	1.32	1.32
Chromium	42.8	385	50.4	50.4
Copper	1,510	46,200	1,310	1,310
Lead	1,310	10,800	1,830	1,830
Manganese	425	3,400	478	478
Mercury	0.432	2.50	0.703	0.703
Nickel	32.4	329	42.2	42.2
Zinc	443	4,170	613	613

NOTES:
* = Maximum Detected Concentration.
UCL = Upper Confidence Limit

TABLE 6-16. EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN SEDIMENT

Chemical	Arithmetic Mean	Maximum Detected Concentration	95% UCL	Exposure Point Concentration
West Middlesex Canal Area				
Semivolatile Organics (µg/kg)				
Benzo(a)anthracene	4,080	2,600	185,000	2,600 *
Benzo(b)fluoranthene	3,870	3,600	137,000	3,600 *
Pesticides & PCBs (µg/kg)				
PCBs	256	2,000	998	998
Inorganics (mg/kg)				
Arsenic	16.4	101	40.6	40.6
Beryllium	0.567	3.80	1.45	1.45
Cadmium	0.771	5.40	1.46	1.46
Chromium	25.4	100	58.0	58.0
Lead	86.9	554	267	267
Manganese	437	2750	995	995
Vanadium	24.1	110	38.3	38.3
Central Wetlands Area				
Semivolatile Organics (µg/kg)				
Benzo(a)anthracene	2,440	40,000	2,980	2,980
Benzo(a)pyrene	1,530	18,000	2,250	2,250
Benzo(b)fluoranthene	3,100	60,000	3,290	3,290
Dibenzo(a,h)anthracene	1,480	140	2,100	140 *
Indeno(1,2,3-cd)pyrene	1,560	18,000	2,440	2,440
Pesticides & PCBs (µg/kg)				
PCBs	54.0	570	65.6	65.6
Inorganics (mg/kg)				
Antimony	12.0	158	16.5	16.5
Arsenic	14.9	40.8	21.1	21.1
Beryllium	0.620	3.70	1.28	1.28
Chromium	20.6	106	34.6	34.6
Copper	259	3,600	673	673
Lead	302	2,970	738	738
Manganese	322	1,230	491	491

TABLE 6-16 (continued). EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN SEDIMENT

Chemical	Arithmetic Mean	Maximum Detected Concentration	95% UCL	Exposure Point Concentration
East Middlesex Canal and Wetlands Area				
Semivolatile Organics (µg/kg)				
Benzo(a)anthracene	3,950	21,000	5,390	5,390
Benzo(a)pyrene	3,620	15,000	5,320	5,320
Benzo(b)fluoranthene	3,780	19,000	5,740	5,740
Benzo(k)fluoranthene	3,680	12,500	4,660	4,660
Dibenzo(a,h)anthracene	3,160	2,950	2,890	2,890
Indeno(1,2,3-cd)pyrene	3,360	7,700	4,090	4,090
Pesticides & PCBs (µg/kg)				
PCBs	75.2	480	94.4	94.4
Inorganics (mg/kg)				
Arsenic	19.6	256	27.1	27.1
Beryllium	0.417	3.20	0.845	0.845
Chromium	11.1	64.6	14.6	14.6
Manganese	383	2,700	665	665
Vanadium	15.6	76.4	18.6	18.6

NOTES:

* = Maximum Detected Concentration.

UCL = Upper Confidence Limit.

TABLE 6-17. EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN SURFACE WATER

Analyte	Arithmetic Mean	Maximum Detected Concentration	95 % UCL	Exposure Point Concentration
West Middlesex Canal Area				
Pesticides and PCBs (µg/l)				
delta-BHC	0.00268	0.016	0.00418	0.00418
Heptachlor Epoxide	0.00145	0.0019	0.00156	0.00156
PCBs	0.0382	0.17	0.0537	0.0537
Inorganics (µg/l)				
Arsenic	11.6	43.3	58.5	43.3 *
Manganese	982	3,530	1,480	1,480
Thallium	1.44	2.05	2.01	2.010
Central Wetlands Area				
Volatile Organics (µg/l)				
1,2-Dichloroethene(total)	5.43	11.5	5.79	5.79
Methylene Chloride	5.17	10	5.38	5.38
Tetrachloroethene	5.52	16	6.11	6.11
Trichloroethene	5.22	8.5	5.44	5.44
Semivolatile Organics (µg/l)				
Benzo(b)fluoranthene	4.86	1.0	5.48	1.0 *
Inorganics (µg/l)				
Arsenic	12.5	155	18.8	18.8
Barium	79.6	842	88.7	88.7
Cadmium	1.69	28.2	1.39	1.39
Chromium	4.29	36.9	5.56	5.56
Copper	28.1	636	22.5	22.5
Lead	34.6	630	52.5	52.5
Manganese	1,080	4,810	1,510	1,510
Nickel	14.7	324	9.68	9.68
Thallium	1.60	2.90	1.88	1.88
Vanadium	3.42	38.9	3.82	3.82
Zinc	204	5,100	146	146

TABLE 6-17 (continued). EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN SURFACE WATER

Analyte	Arithmetic Mean	Maximum Detected Concentration	95 % UCL	Exposure Point Concentration
East Middlesex Canal and Wetlands Area				
Volatile Organics (µg/l)				
Benzene	4.80	1.0	5.44	1.0 *
Chloromethane	4.95	3.0	5.06	3.0 *
Semivolatile Organics (µg/l)				
Benzo(a)anthracene	4.90	1.0	5.32	1.0 *
Benzo(b)fluoranthene	4.93	2.0	5.13	2.0 *
1,4-Dichlorobenzene	4.83	2.0	5.31	2.0 *
4-Methylphenol	16.5	440	10.2	10.2
Pesticides and PCBs (µg/l)				
Aldrin	0.00179	0.014	0.00191	0.00191
gamma-BHC(Lindane)	0.00379	0.066	0.00322	0.00322
PCBs	0.0304	0.24	0.0313	0.0313
Inorganics (µg/l)				
Antimony	8.61	30.2	9.61	9.61
Arsenic	436	13,000	796	796
Barium	488	10,300	465	465
Beryllium	0.254	1.60	0.287	0.287
Chromium	9.64	133	9.52	9.52
Copper	13.7	299	10.4	10.4
Lead	42.8	551	72.3	72.3
Manganese	1,440	13,500	3,010	3,010
Nickel	11.4	118	13.7	13.7
Selenium	2.70	27.6	2.66	2.66
Silver	4.56	54.0	4.29	4.29
Thallium	1.69	23.8	1.65	1.65
Vanadium	14.3	211	15.4	15.4
Zinc	104	2,780	98.8	98.8

NOTES:
* = Maximum Detected Concentration.
UCL = Upper Confidence Limit

TABLE 6-18. EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

Analyte	Arithmetic Mean	Maximum Detected	95% UCL	Exposure Point Concentration Central Tendency		Exposure Point Concentration RME Case
B&M Railroad Landfill - Shallow Overburden						
Semivolatile Organics (µg/l)						
Carbazole	4.90	6.0	5.49	4.9		6.0 *
4-Methylphenol	8.10	37	12.2	8.1		37 *
Pesticides and PCBs (µg/l)						
Aldrin	0.00255	0.010	0.00389	0.00255		0.010 *
PCBs	0.0495	0.15	0.080	0.0495		0.15 *
Inorganics (µg/l)						
Antimony	1.73	4.70	2.53	1.73		4.70 *
Arsenic	11.8	55.6	57.8	11.8		55.6 *
Barium	374	2,000	11,500	374		2000 *
Lead	6.78	32.7	31.1	6.78		32.7 *
Manganese	1,230	5,420	23,000,000,000	1230		5420 *
B&M Railroad Landfill - Deep Overburden						
Volatile Organics (µg/l)						
Chlorobenzene	4.83	4.0	5.07	4.0	*	4.0 *
1,2-Dichloroethane	4.33	3.0	5.04	3.0	*	3.0 *
1,1-Dichloroethene	5.12	7.5	5.52	5.12		7.5 *
Trichloroethene	11.8	52.5	21.2	11.8		52.5 *
Pesticides and PCBs (µg/l)						
PCBs	0.0267	0.020	0.0286	0.020	*	0.020 *
Inorganics (µg/l)						
Manganese	405	922	98,600	405		922 *
B&M Railroad Landfill - Bedrock						
Volatile Organics (µg/l)						
Chloroform	4.70	6.0	5.81	4.7		6.0 *
1,2-Dichloroethane	5.90	9.0	6.77	5.9		9.0 *
1,1-Dichloroethene	5.10	9.0	6.10	5.1		9.0 *
1,2-Dichloroethene(total)	4.90	8.0	5.93	4.9		8.0 *
Trichloroethene	16.6	50	47.5	16.6		50 *
Semivolatile Organics (µg/l)						
Bis(2-ethylhexyl)phthalate	6.15	9.0	7.54	6.15		9.0 *

TABLE 6-18 (Continued). EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

				Exposure Point Concentration	
Analyte	Arithmetic Mean	Maximum Detected	95% UCL	Central Tendency	RME Case
Inorganics (µg/l)					
Arsenic	6.82	19.6	16.9	6.82	19.6 *
Manganese	295	1,260	853,000	295	1260 *
RSI Landfill - Shallow Overburden					
Volatile Organics (µg/l)					
Benzene	53.9	350	148	53.9	350 *
Semivolatile Organics (µg/l)					
1,4-Dichlorobenzene	4.86	3.0	5.20	3.0 *	3.0 *
Pesticides and PCBs (µg/l)					
beta-BHC	0.00429	0.040	0.00538	0.00429	0.040 *
PCBs	0.0234	0.010	0.0359	0.01 *	0.010 *
Inorganics (µg/l)					
Arsenic	39.5	186	82.50	39.5	186 *
Manganese	966	2,440	11,100	966	2440 *
RSI Landfill - Deep Overburden					
Volatile Organics (µg/l)					
1,2-Dichloroethene(total)	5.20	8.0	5.79	5.2	8.0 *
1,1,2,2-Tetrachloroethane	5.0	5.0	5.0	5.0	5.0 *
Trichloroethene	8.40	23	13.4	8.4	23 *
Pesticides and PCBs (µg/l)					
PCBs	0.0307	0.080	0.070	0.0307	0.08 *
Inorganics (µg/l)					
Arsenic	68.5	345	866	68.5	345 *
Barium	115	419	325	115	419 *
Cadmium	0.800	2.0	1.76	0.8	2.0 *
Chromium	3.27	20.6	16.8	3.27	20.6 *
Cyanide	35.6	208	457	35.6	208 *
Lead	4.10	25.2	11.8	4.1	25.2 *
Manganese	2,770	6,400	4,580	2770	6400 *
Thallium	3.89	9.0	6.84	3.89	9.0 *

TABLE 6-18 (Continued). EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

				Exposure Point Concentration	
Analyte	Arithmetic Mean	Maximum Detected	95% UCL	Central Tendency	RME Case
RSI Landfill - Bedrock					
Volatile Organics (μg/l)					
1,2-Dichloroethane	4.45	6.0	5.77	4.45	6.0 *
1,1-Dichloroethene	4.70	2.0	5.76	2.0 *	2.0 *
Tetrachloroethene	4.60	3.0	5.29	3.0 *	3.0 *
Trichloroethene	4.60	5.0	5.29	4.6	5.0 *
Pesticides and PCBs (μg/l)					
Heptachlor Epoxide	0.00170	0.0020	0.00186	0.0017	0.0020 *
PCBs	0.0320	0.080	0.0406	0.032	0.080 *
Inorganics (μg/l)					
Arsenic	5.28	11.9	9.65	5.28	11.9 *
Cyanide	46.5	189	2,610	46.5	189 *
Manganese	589	2,690	849,000	589	2690 *
Silver	6.04	27.4	93.6	6.04	27.4 *
B&M Locomotive Shop Disposal Area - Shallow Overburden					
Volatile Organics (μg/l)					
1,2-Dichloroethane	4.75	3.0	5.44	3.0 *	3.0 *
1,1,2,2-Tetrachloroethane	4.75	3.0	5.44	3.0 *	3.0 *
Pesticides and PCBs (μg/l)					
Heptachlor Epoxide	0.00169	0.0030	0.00202	0.00169	0.0030 *
Inorganics (μg/l)					
Arsenic	3.04	4.30	5.46	3.04	4.3 *
Manganese	2295	11,000	22,900,000	2295	11,000 *
B&M Locomotive Shop Disposal Area - Deep Overburden					
Pesticides and PCBs (μg/l)					
PCBs	0.0226	0.0090	0.0416	0.0090 *	0.0090 *
Inorganics (μg/l)					
Arsenic	5.56	16.6	20.7	5.56	16.6 *
Manganese	160	829	2,610,000	160	829 *
B&M Locomotive Shop Disposal Area - Bedrock					
Pesticides and PCBs (μg/l)					
PCBs	0.0212	0.010	0.0506	0.010 *	0.010 *

TABLE 6-18 (Continued). EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

Analyte	Arithmetic Mean	Maximum Detected	95% UCL	Exposure Point Concentration Central Tendency	RME Case
Inorganics (μg/l)					
Arsenic	3.30	5.10	7.54	3.30	5.10 *
Manganese	270	519	1,360	270	519 *
Old B&M Oil/Sludge Recycling Area - Shallow Overburden					
Semivolatile Organics (μg/l)					
Bis(2-ethylhexyl)phthalate	4.83	5.0	5.24	4.83	5.0 *
Pesticides and PCBs (μg/l)					
PCBs	0.0242	0.020	0.0291	0.020 *	0.020 *
Inorganics (μg/l)					
Arsenic	7.43	27.1	15.9	7.43	27.1 *
Manganese	541	1,480	1,800	541	1,480 *
Old B&M Oil/Sludge Recycling Area - Deep Overburden					
Pesticides and PCBs (μg/l)					
Heptachlor Epoxide	0.00151	0.0020	0.00182	0.00151	0.0020 *
Inorganics (μg/l)					
Arsenic	3.60	7.40	5.75	3.60	7.40 *
Manganese	455	1,370	7,100	455	1,370 *
Old B&M Oil/Sludge Recycling Area - Bedrock					
Volatile Organics (μg/l)					
Chloroform	4.80	3.0	5.33	3.0 *	3.0 *
Inorganics (μg/l)					
Arsenic	4.23	9.60	6.13	4.23	9.60 *
Manganese	334	1,370	8,200	334	1370 *
Nickel	14.5	112	50.0	14.5	112 *
Asbestos Lagoons - Shallow Overburden					
Volatile Organics (μg/l)					
1,1,2,2-Tetrachloroethane	4.80	3.0	5.33	3.0 *	3.0 *
Inorganics (μg/l)					
Arsenic	18.4	58.1	128	18.4	58.1 *
Lead	7.70	63.6	23.4	7.7	63.6 *
Manganese	516	1,020	503,000	516	1020 *

TABLE 6-18 (Continued). EXPOSURE POINT CONCENTRATIONS FOR CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER

Analyte	Arithmetic Mean	Maximum Detected	95% UCL	Exposure Point Concentration Central Tendency	Exposure Point Concentration RME Case
<u>Asbestos Lagoons - Deep Overburden</u>					
Volatile Organics (µg/l)					
1,2-Dichloroethane	4.50	3.0	5.38	3.0 *	3.0 *
Semivolatile Organics (µg/l)					
Bis(2-ethylhexyl)phthalate	5.75	13	8.03	5.75	13 *
Pesticides and PCBs (µg/l)					
Heptachlor Epoxide	0.00231	0.0050	0.00360	0.00231	0.0050 *
Inorganics (µg/l)					
Arsenic	5.67	17.3	21.5	5.67	17.3 *
Beryllium	0.634	2.40	7.0	0.634	2.40 *
Manganese	2,410	4,160	4,580	2410	4160 *
<u>Asbestos Lagoons - Bedrock</u>					
Volatile Organics (µg/l)					
1,2-Dichloroethane	15.4	39	227	15.4	39 *
Semivolatile Organics (µg/l)					
Bis(2-ethylhexyl)phthalate	7.0	17	12.5	7.0	17 *
Pesticides and PCBs (µg/l)					
Heptachlor Epoxide	0.00225	0.0050	0.00390	0.00225	0.0050 *
PCBs	0.0617	0.10	0.0808	0.0617	0.10 *
Inorganics (µg/l)					
Beryllium	0.700	2.10	87.6	0.70	2.10 *
Cadmium	0.925	2.05	4.37	0.925	2.05 *
Lead	4.76	21.0	42.2	4.76	21.0 *
Manganese	3,200	8,745	75,600	3200	8745 *
Nickel	38.8	122	127,000	38.8	122 *

NOTES:
* = Maximum Detected Concentration.
UCL = Upper Confidence Limit.

TABLE 6-19. EXPOSURE PARAMETERS FOR INCIDENTAL INGESTION OF CHEMICALS IN SURFACE SOIL OR SEDIMENT BY TRESPASSERS AT IRON HORSE PARK SITE

$$ADD,LADD = \frac{C_s * IR_s * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Central Tendency Exposure Case	Reasonable Maximum Exposure (RME) Case	Source
Average Daily Dose (mg/kg-day)	ADD	--	--	--
Lifetime Average Daily Dose (mg/kg-day)	LADD	--	--	--
Chemical Concentration in Soil/Sediment (mg/kg)	C_s	--	--	--
Ingestion Rate (mg/day)	IR_s	50	100	U.S. EPA, 1991b
Exposure Frequency (days/year)	EF	26	52	professional judgement
Exposure Duration (years)	ED	5	10	professional judgement
Conversion Factor (kg/10^6 mg)	CF	--	--	--
Body Weight (kg)	BW	45	45	U.S. EPA, 1985b
Averaging Time (years)	AT			
Carcinogens		70	70	U.S. EPA, 1989g
Noncarcinogens		5	10	U.S. EPA, 1989g
Conversion Factor (365 days/year)	Days	--	--	--

TABLE 6-20. EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SURFACE SOIL OR SEDIMENT BY TRESPASSERS AT IRON HORSE PARK SITE

$$ADD,LADD = \frac{C_s * SA * AF * Ab * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Central Tendency Exposure Case	Reasonable Maximum Exposure (RME) Case	Source
Average Daily Dose (mg/kg-day)	ADD	--	--	--
Lifetime Average Daily Dose (mg/kg-day)	LADD	--	--	--
Chemical Concentration in Soil/Sediment (mg/kg)	C_s	--	--	--
Skin Surface Area Available for Contact (cm^2)	SA	3,300	4,100	U.S. EPA, 1992b
Soil-to-Skin Adherence Factor (mg/cm^2-day)	AF	0.2	1.0	U.S. EPA, 1992b
Chemical Specific Dermal Absorption Factor (dimensionless)	Ab	--	--	U.S. EPA, 1992b
Exposure Frequency (days/year)	EF	26	52	professional judgement
Exposure Duration (years)	ED	5	10	professional judgement
Conversion Factor (kg/10^6 mg)	CF	--	--	--
Body Weight (kg)	BW	45	45	U.S. EPA, 1985b
Averaging Time (years)	AT			
Carcinogens		70	70	U.S. EPA, 1989g
Noncarcinogens		5	10	U.S. EPA, 1989g
Conversion Factor (365 days/year)	Days	--	--	--

TABLE 6-21. EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF ORGANIC CHEMICALS IN SURFACE WATER BY TRESPASSERS AT IRON HORSE PARK SITE

$$ADD,LADD = \frac{DA^{1} * SA * EV * EF * ED}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Central Tendency Exposure Case	Reasonable Maximum Exposure (RME) Case	Source
Average Daily Dose (mg/kg-day)	ADD	--	--	--
Lifetime Average Daily Dose (mg/kg-day)	LADD	--	--	--
Dose Absorbed Per Unit Area Per Event (mg/cm^2-event)	DA	--	--	U.S. EPA, 1992b
Skin Surface Area Available for Contact (cm^2)	SA	3,300	4,100	U.S. EPA, 1992b
Event Frequency (events/day)	EV	1	1	U.S. EPA, 1992b
Exposure Frequency (days/year)	EF	26	52	professional judgement
Exposure Duration (years)	ED	5	10	professional judgement
Body Weight (kg)	BW	45	45	U.S. EPA, 1985b
Averaging Time (years)	AT			
Carcinogens		70	70	U.S. EPA, 1989g
Noncarcinogens		5	10	U.S. EPA, 1989g
Conversion Factor (365 days/year)	Days	--	--	--

1 Equations used to calculate DA are presented in Appendix G-2.

TABLE 6-22. EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF INORGANIC CHEMICALS IN SURFACE WATER BY TRESPASSERS AT IRON HORSE PARK SITE

$$ADD,LADD = \frac{C_{sw} * SA * K_p * CF * EV * ET * EF * ED}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Central Tendency Exposure Case	Reasonable Maximum Exposure (RME) Case	Source
Average Daily Dose (mg/kg-day)	ADD	--	--	--
Lifetime Average Daily Dose (mg/kg-day)	LADD	--	--	--
Chemical Concentration in Surface Water (μg/L)	C_{sw}	--	--	--
Skin Surface Area Available for Contact (cm^2)	SA	3,300	4,100	U.S. EPA, 1992b
Chemical Specific Permeability Coefficient (cm/hr)	K_p	--	--	U.S. EPA, 1992b
Conversion Factor (10^{-3} L/cm^3 * 10^{-3} mg/μg)	CF	--	--	U.S. EPA, 1992b
Event Frequency (events/day)	EV	1	1	U.S. EPA, 1992b
Exposure Time (hours/event)	ET	1	2	professional judgement
Exposure Frequency (days/year)	EF	26	52	professional judgement
Exposure Duration (years)	ED	5	10	professional judgment
Body Weight (kg)	BW	45	45	U.S. EPA, 1985b
Averaging Time (years)	AT			
Carcinogens		70	70	U.S. EPA, 1989g
Noncarcinogens		5	10	U.S. EPA, 1989g
Conversion Factor (365 days/year)	Days	--	--	--

TABLE 6-23. EXPOSURE PARAMETERS FOR INCIDENTAL INGESTION OF CHEMICALS IN SURFACE SOIL BY ADULT WORKERS AT IRON HORSE PARK SITE

$$ADD,LADD = \frac{C_s * IR_s * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Central Tendency Exposure Case	Reasonable Maximum Exposure (RME) Case	Source
Average Daily Dose (mg/kg-day)	ADD	--	--	--
Lifetime Average Daily Dose (mg/kg-day)	LADD	--	--	--
Chemical Concentration in Surface Soil (mg/kg)	C_s	--	--	--
Ingestion Rate (mg/day)	IR_s	50	100	U.S. EPA, 1994e
Exposure Frequency (days/year)	EF	150	150	U.S. EPA, 1994e
Exposure Duration (years)	ED	15	25	BLS, 1987; U.S. EPA, 1994e
Conversion Factor (kg/10^6 mg)	CF	--	--	--
Body Weight (kg)	BW	70	70	U.S. EPA, 1994e
Averaging Time (years)	AT			
Carcinogens		70	70	U.S. EPA, 1989g
Noncarcinogens		15	25	U.S. EPA, 1989g
Conversion Factor (365 days/year)	Days	--	--	--

TABLE 6-24. EXPOSURE PARAMETERS FOR DERMAL ABSORPTION OF CHEMICALS IN SURFACE SOIL BY ADULT WORKERS AT IRON HORSE PARK SITE

$$ADD,LADD = \frac{C_s * SA * AF * Ab * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Central Tendency Exposure Case	Reasonable Maximum Exposure (RME) Case	Source
Average Daily Dose (mg/kg-day)	ADD	--	--	--
Lifetime Average Daily Dose (mg/kg-day)	LADD	--	--	--
Chemical Concentration in Surface Soil (mg/kg)	C_s	--	--	--
Skin Surface Area Available for Contact (cm^2)	SA	5,000	5,800	U.S. EPA, 1985b
Soil-to-Skin Adherence Factor (mg/cm^2-day)	AF	0.2	1.0	U.S. EPA, 1992b
Chemical-Specific Dermal Absorption Factor (dimensionless)	Ab	--	--	U.S. EPA, 1992b
Exposure Frequency (days/year)	EF	150	150	U.S. EPA, 1994e
Exposure Duration (years)	ED	15	25	BLS, 1987; U.S. EPA, 1994e
Conversion Factor (kg/10^6 mg)	CF	--	--	--
Body Weight (kg)	BW	70	70	U.S. EPA, 1994e
Averaging Time (years)	AT			
Carcinogens		70	70	U.S. EPA, 1989g
Noncarcinogens		15	25	U.S. EPA, 1989g
Conversion Factor (365 days/year)	Days	--	--	--

TABLE 6-25 EXPOSURE PARAMETERS FOR INGESTION OF CHEMICALS IN GROUNDWATER BY HYPOTHETICAL RESIDENTS AT IRON HORSE PARK SITE [FUTURE LAND-USE CONDITIONS]

$$ADD,LADD = \frac{C_{gw} * IR * EF * ED * CF}{BW * AT * Days}$$

Parameter	Parameter Abbreviation	Central Tendency Exposure Case	Reasonable Maximum Exposure (RME) Case	Source
Average Daily Dose (mg/kg-day)	ADD	--	--	--
Lifetime Average Daily Dose (mg/kg-day)	LADD	--	--	
Chemical Concentration in Groundwater (μg/l)	C_{gw}	--	--	--
Ingestion Rate (l/day)	IR	1.4	2	U.S. EPA, 1994e
Exposure Frequency (days/year)	EF	350	350	U.S. EPA, 1994e
Exposure Duration (years)	ED	9	30	U.S. EPA, 1994e
Conversion Factor (mg/10^3 μg)	CF	--	--	--
Body Weight (kg)	BW	70	70	U.S. EPA, 1994e
Averaging Time (years)	AT			
Carcinogens		70	70	U.S. EPA, 1989g
Noncarcinogens		9	30	U.S. EPA, 1989g
Conversion Factor (365 days/year)	Days	--	--	--

TABLE 6-26. CHRONIC ORAL TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN

Chemical	Toxicity Criteria For Carcinogenic Effects: Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight-of-Evidence Class (1)	Slope Factor Source	Toxicity Criteria for Noncarcinogenic Effects: Chronic Oral Reference Dose (RfD) (mg/kg-day)	Uncertainty Factor (2)	Target Organ/Critical Effect (3)	RfD Source
Volatile Organics:							
Benzene	2.9E-02	A	USEPA 1996c	---	---	---	---
Chlorobenzene	---	D	USEPA 1996c	2.0E-02	1,000	liver	USEPA 1996c
Chloroform	6.1E-03	B2	USEPA 1996c	1.0E-02	1,000	liver	USEPA 1996c
Chloromethane	1.3E-02	C	USEPA 1995a	---	---	---	---
1,2-Dichloroethane	9.1E-02	B2	USEPA 1996c	---	---	---	---
1,2-Dichloroethene (total)	---	---	---	9.0E-03	1,000	liver	USEPA 1995a
1,1-Dichloroethene	6.0E-01	C	USEPA 1996c	9.0E-03	1,000	liver	USEPA 1996c
2-Hexanone	---	---	---	---	---	---	---
Methylene Chloride	7.5E-03	B2	USEPA 1996c	6.0E-02	100	liver	USEPA 1996c
1,1,2,2-Tetrachloroethane	2.0E-01	C	USEPA 1996c	---	---	---	---
Tetrachloroethene	5.2E-02	B2/C	USEPA 1996c	1.0E-02	1,000	liver	USEPA 1996c
Trichloroethene	1.1E-02	B2/C	USEPA 1996c	---	---	---	---
Semivolatile Organics:							
Benzo(a)anthracene	7.3E-01 (4)	B2	USEPA 1994e	---	---	---	---
Benzo(a)pyrene	7.3E+00	B2	USEPA 1996c	---	---	---	---
Benzo(b)fluoranthene	7.3E-01 (4)	B2	USEPA 1994e	---	---	---	---
Benzo(k)fluoranthene	7.3E-02 (4)	B2	USEPA 1994e	---	---	---	---
Bis(2-ethylhexyl)phthalate	1.4E-02	B2	USEPA 1996c	2.0E-02	1,000	liver	USEPA 1996c
Carbazole	2.0E-02	B2	USEPA 1995a	---	---	---	---
Dibenzo(a,h)anthracene	7.3E+00 (4)	B2	USEPA 1994e	---	---	---	---
1,4-Dichlorobenzene	2.4E-02	C	USEPA 1995a	---	---	---	---
Indeno(1,2,3-c,d)pyrene	7.3E-01 (4)	B2	USEPA 1994e	---	---	---	---
4-Methylphenol	---	C	USEPA 1996c	5.0E-03	1,000	CNS	USEPA 1995a
Pentachlorophenol	1.2E-01	B2	USEPA 1996c	3.0E-02	100	liver/kidney	USEPA 1996c
Pesticides and PCBs:							
Aldrin	1.7E+01	B2	USEPA 1996c	3.0E-05	1,000	liver	USEPA 1996c
alpha-BHC	6.3E+00	B2	USEPA 1996c	---	---	---	---
beta-BHC	1.8E+00	C	USEPA 1996c	---	---	---	---
delta-BHC	---	D	USEPA 1996c	---	---	---	---
gamma-BHC	1.3E+00	B2/C	USEPA 1995a	3.0E-04	1,000	liver/kidney	USEPA 1996c

TABLE 6-26(Continued). CHRONIC ORAL TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN

Chemical	Toxicity Criteria For Carcinogenic Effects			Toxicity Criteria for Noncarcinogenic Effects			
	Oral Slope Factor (mg/kg-day)$^{-1}$	Weight-of-Evidence Class (1)	Slope Factor Source	Chronic Oral Reference Dose (RfD) (mg/kg-day)	Uncertainty Factor (2)	Target Organ/Critical Effect (3)	RfD Source
4,4-DDT	3.4E-01	B2	USEPA 1996c	5.0E-04	100	liver	USEPA 1995a
Heptachlor Epoxide	9.1E+00	B2	USEPA 1996c	1.3E-05	1,000	liver	USEPA 1995a
PCBs (5)	various (5)	B2	USEPA 1996c	---	---	---	---
Inorganics:							
Antimony	---	---	---	4.0E-04	1,000	blood chemistry	USEPA 1996c
Arsenic	1.5E+00	A	USEPA 1996c	3.0E-04	3	skin	USEPA 1996c
Barium	---	---	---	7.0E-02	3	increased BP	USEPA 1996c
Beryllium (6)	4.3E+00	B2	USEPA 1996c	5.0E-03	100	none observed	USEPA 1996c
Cadmium (aqueous)	---	B1	USEPA 1996c	5E-04 (7)	10	kidney	USEPA 1996c
Cadmium (nonaqueous)	---	B1	USEPA 1996c	1E-03 (8)	10	kidney	USEPA 1996c
Chromium VI (6)	---	A	USEPA 1996c	5.0E-03	500	CNS (9)	USEPA 1996c
Chromium III (6)	---	---	---	1.0E+00	100 (10)	none observed	USEPA 1996c
Copper	---	D	USEPA 1996c	3.7E-02 (11)	1	GI system	USEPA 1995a
Cyanide	---	D	USEPA 1996c	2.0E-02	100 (12)	nervous system	USEPA 1996c
Lead	---	B2	USEPA 1996c	---	---	---	---
Manganese	---	D	USEPA 1996c	2.4E-02 (13)	3	CNS	USEPA 1996c
Mercury	---	D	USEPA 1996c	3.0E-04	1,000	kidney	USEPA 1995a
Nickel (6)	---	---	---	2.0E-02	300	low body weight	USEPA 1996c
Selenium	---	D	USEPA 1996c	5.0E-03	3	selenosis	USEPA 1996c
Silver	---	D	USEPA 1996c	5.0E-03	3	argyria	USEPA 1995a
Thallium	---	D	USEPA 1996c	8E-05 (14)	3,000	liver	USEPA 1996c
Vanadium	---	---	---	7.0E-03	100	none observed	USEPA 1995a
Zinc	---	D	USEPA 1996c	3E-01	3	blood chemistry	USEPA 1996c

NOTES:

1. U.S. EPA weight-of-evidence classification scheme for carcinogens:
   A = Human Carcinogen, sufficient evidence of carcinogenicity in humans;
   B1 = Probable Human Carcinogen, limited human data are available;
   B2 = Probable Human Carcinogen, sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans;
   C = Possible Human Carcinogen, limited evidence from animal studies in the absence of human studies; and
   D = Not classified as to human carcinogenicity, inadequate or no evidence.

TABLE 6-26(Continued). CHRONIC ORAL TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN

NOTES (continued):

2. Uncertainty factors presented are the products of specific uncertainty factors and modifying factors. Uncertainty factors used to develop reference doses generally consist of multiples of 10, with each factor representing a specific area of uncertainty in the data available. The standard uncertainty factors include:
   - a 10-fold factor to account for the variation in sensitivity among the members of the human population;
   - a 10-fold factor to account for the uncertainty in extrapolating animal data to the case of humans;
   - a 10-fold factor to account for the uncertainty in extrapolating from less-than-chronic NOAELs to chronic NOAELs;
   - a 10-fold factor to account for the uncertainty in extrapolating from LOAELs to NOAELs.

   Modifying factors are applied at the discretion of the RfD/RfC reviewer to cover other uncertainties in the data and range from 1 to 10. Modifying factors for chemicals of potential concern in this table equal one, except where noted.
3. A target organ or critical effect is the organ/effect most sensitive to the chemical exposure. RfDs are based on toxic effects in the target organ or critical effects. If an RfD is based on a study in which a target organ or critical effect was not identified, the organ/effect listed is one known to be affected by or associated with the chemical. A more detailed description of the studies are provided in the toxicity profile.
4. The slope factor for benzo(a)pyrene was used as a surrogate to evaluate carcinogenic PAHs, along with relative potency values obtained from U.S. EPA Region 1 *Risk Update number 2* (U.S. EPA, 1994e).
5. The cancer potency of PCBs depends on the relative composition. The composition of PCBs at the site varies, and the composition to which receptors would be exposed has associated uncertainty. The slope factor assumed for central tendency estimates is 1.0 per mg/kg/day; the RME slope factor is 2.0 per mg/kg/day. Toxicity other than cancer also varies by composition and no attempt to estimate noncarcinogenic hazard from PCBs has been made. See text.
6. Values for beryllium and nickel are specifically for soluble salts, but are used for all exposures in the risk assessment. Value for chromium III is for insoluble salts; however, it should be noted that chromium VI value will be used to assess all chromium exposures.
7. This RfD is based on and is used to assess aqueous exposures.
8. This RfD is based on and is used to assess non-aqueous exposures.
9. Because the RfD for chromium VI was derived from a toxicity study in which no effects were noted, one of the more sensitive toxicological effects, central nervous system effects, was designated as the target organ of concern.
10. An additional modifying factor of 10 was also used to adjust the chromium III RfD.
11. This value was converted from a value of 1.3 mg/liter using an ingestion rate of 2 liters/day for a 70 kg individual.
12. An additional modifying factor of 5 was used to adjust the cyanide RfD.
13. The RfD is based on the total allowable intake for manganese minus the background intake. In addition, an uncertainty factor of 3 was applied to this RfD, except for soil and sediment exposures, where the RfD used was 0.07 mg/kg/day (U.S. EPA, 1997).
14. This RfD value is for thallium carbonate, thallium chloride, and thallium sulfate. Value for thallium is for salts, but is used to assess all thallium exposures.

U.S. EPA, 1994e = U.S. EPA Region 1 *Risk Update number 2*

U.S. EPA, 1995a = HEAST or Health Effects Assessment Summary Tables

TABLE 6-26(Continued). CHRONIC ORAL TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN

NOTES (continued):

U.S. EPA, 1996c = IRIS or Integrated Risk Information System

NCEA = U.S. EPA, National Center for Environmental Assessment, formerly ECAO. The provisional oral slope factor values were obtained from NCEA, and were not provided by U.S. EPA specifically for Iron Horse.

CNS = central nervous system

BP = blood pressure.

GI = gastrointestinal

RfD = Reference Dose

--- = no information available.

TABLE 6-27. INCREMENTAL LIFETIME CANCER RISK TO THE TRESPASSER RECEPTOR FROM THE INGESTION OF SURFACE SOIL

Carcinogenic Chemical	RME Exposure Point Concentration		Central Tendency Exposure Case (LADD)	RME Case (LADD)	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
B&M Railroad Landfill								
Semivolatile Organics (µg/kg)								
Benzo(a)anthracene	11,100		6.28E-08	5.02E-07	7.3E-01	B2	4.58E-08	3.66E-07
Benzo(a)pyrene	11,300		6.39E-08	5.11E-07	7.3E+00	B2	4.66E-07	3.73E-06
Benzo(b)fluoranthene	26,400		1.49E-07	1.19E-06	7.3E-01	B2	1.09E-07	8.72E-07
Dibenzo(a,h)anthracene	4,200	*	2.37E-08	1.90E-07	7.3E+00	B2	1.73E-07	1.39E-06
Indeno(1,2,3-c,d)pyrene	8,410		4.75E-08	3.80E-07	7.3E-01	B2	3.47E-08	2.78E-07
Inorganics (mg/kg)								
Arsenic	27.0		1.53E-07	1.22E-06	1.5E+00	A	2.29E-07	1.83E-06
Total:							1.06E-06	8.46E-06
RSI Landfill								
Inorganics (mg/kg)								
Arsenic	4.77		2.70E-08	2.16E-07	1.5E+00	A	4.05E-08	3.24E-07
Total:							4.05E-08	3.24E-07
B&M Locomotive Shop Disposal Area								
Semivolatile Organics (µg/kg)								
Benzo(a)anthracene	2,300	*	1.30E-08	1.04E-07	7.3E-01	B2	9.49E-09	7.59E-08
Benzo(a)pyrene	1,700	*	9.61E-09	7.69E-08	7.3E+00	B2	7.02E-08	5.61E-07
Benzo(b)fluoranthene	2,900	*	1.64E-08	1.31E-07	7.3E-01	B2	1.20E-08	9.57E-08
Dibenzo(a,h)anthracene	366		2.07E-09	1.66E-08	7.3E+00	B2	1.51E-08	1.21E-07
Indeno(1,2,3-c,d)pyrene	920	*	5.20E-09	4.16E-08	7.3E-01	B2	3.80E-09	3.04E-08
Inorganics (mg/kg)								
Arsenic	49.3	*	2.78E-07	2.23E-06	1.5E+00	A	4.18E-07	3.34E-06
Beryllium	0.850	*	4.81E-09	3.84E-08	4.3E+00	B2	2.07E-08	1.65E-07
Total:							5.49E-07	4.39E-06

TABLE 6-27 (Continued). INCREMENTAL LIFETIME CANCER RISK TO THE TRESPASSER RECEPTOR FROM THE INGESTION OF SURFACE SOIL

Carcinogenic Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (LADD)	RME Case (LADD)	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
Old B&M Oil/Sludge Recycling Area							
Inorganics (mg/kg)							
Arsenic	10.5	5.94E-08	4.75E-07	1.5E+00	A	8.90E-08	7.12E-07
Beryllium	0.199	1.13E-09	9.00E-09	4.3E+00	B2	4.84E-09	3.87E-08
Total:						9.39E-08	7.51E-07
Contaminated Soil Area							
Semivolatile Organics (μg/kg)							
Benzo(a)anthracene	2,530	1.43E-08	1.14E-07	7.3E-01	B2	1.04E-08	8.35E-08
Benzo(a)pyrene	2,530	1.43E-08	1.14E-07	7.3E+00	B2	1.04E-07	8.35E-07
Benzo(b)fluoranthene	3,960	2.24E-08	1.79E-07	7.3E-01	B2	1.63E-08	1.31E-07
Dibenzo(a,h)anthracene	1,960	1.11E-08	8.86E-08	7.3E+00	B2	8.09E-08	6.47E-07
Indeno(1,2,3-c,d)pyrene	2,160	1.22E-08	9.77E-08	7.3E-01	B2	8.91E-09	7.13E-08
Pentachlorophenol	6,310	3.57E-08	2.85E-07	1.2E-01	B2	4.28E-09	3.42E-08
Pesticides and PCBs (μg/kg)							
4,4'-DDT	84.6	4.78E-10	3.83E-09	3.4E-01	B2	1.63E-10	1.30E-09
Inorganics (mg/kg)							
Arsenic	29.3	1.66E-07	1.33E-06	1.5E+00	A	2.48E-07	1.99E-06
Total:						4.74E-07	3.79E-06

Notes:
* = Maximum Detected Concentration.

TABLE 6-28. HAZARD INDEX FOR THE TRESPASSER RECEPTOR FROM THE INGESTION OF SURFACE SOIL

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (ADD)	RME Case (ADD)	RfD [Uncertainty Factor]	Target Organ/Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
B&M Railroad Landfill							
Inorganics (mg/kg)							
Antimony	23.3	1.84E-06	7.38E-06	4.0E-04 [1000]	blood chemistry	4.61E-03	1.84E-02
Arsenic	27.0	2.14E-06	8.55E-06	3.0E-04 [3]	skin	7.12E-03	2.85E-02
Barium	744	5.89E-05	2.36E-04	7.0E-02 [3]	increased BP	8.41E-04	3.36E-03
Cadmium	34.8 *	2.75E-06	1.10E-05	1.0E-03 [10]	kidney	2.75E-03	1.10E-02
Chromium	201	1.59E-05	6.36E-05	5.0E-03 [500]	CNS	3.18E-03	1.27E-02
Copper	878	6.95E-05	2.78E-04	3.7E-02 [1]	GI system	1.88E-03	7.51E-03
Manganese	609	4.82E-05	1.93E-04	7.0E-02 [3]	CNS	6.89E-04	2.75E-03
Mercury	3.40 *	2.69E-07	1.08E-06	3.0E-04 [1000]	kidney	8.97E-04	3.59E-03
Zinc	4,400 *	3.48E-04	1.39E-03	3.0E-01 [3]	blood chemistry	1.16E-03	4.64E-03
Hazard Index:						2.31E-02	9.25E-02
RSI Landfill							
Inorganics (mg/kg)							
Arsenic	4.77	3.78E-07	1.51E-06	3.0E-04 [3]	skin	1.26E-03	5.03E-03
Manganese	197	1.56E-05	6.24E-05	7.0E-02 [3]	CNS	2.23E-04	8.91E-04
Hazard Index:						1.48E-03	5.92E-03
B&M Locomotive Shop Disposal Area							
Inorganics (mg/kg)							
Antimony	53.0 *	4.19E-06	1.68E-05	4.0E-04 [1000]	blood chemistry	1.05E-02	4.19E-02
Arsenic	49.3 *	3.90E-06	1.56E-05	3.0E-04 [3]	skin	1.30E-02	5.20E-02
Beryllium	0.850 *	6.73E-08	2.69E-07	5.0E-03 [100]	none observed	1.35E-05	5.38E-05
Chromium	87.4 *	6.92E-06	2.77E-05	5.0E-03 [500]	CNS	1.38E-03	5.53E-03
Copper	3,140 *	2.49E-04	9.94E-04	3.7E-02 [1]	GI system	6.72E-03	2.69E-02
Manganese	917 *	7.26E-05	2.90E-04	7.0E-02 [3]	CNS	1.04E-03	4.15E-03
Hazard Index:						3.26E-02	1.31E-01

TABLE 6-28 (Continued). HAZARD INDEX FOR THE TRESPASSER RECEPTOR FROM THE INGESTION OF SURFACE SOIL

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (ADD)	RME Case (ADD)	RfD [Uncertainty Factor]	Target Organ/Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
Old B&M Oil/Sludge Recycling Area							
Inorganics (mg/kg)							
Antimony	14.1	1.12E-06	4.46E-06	4.0E-04 [1000]	blood chemistry	2.79E-03	1.12E-02
Arsenic	10.5	8.31E-07	3.32E-06	3.0E-04 [3]	skin	2.77E-03	1.11E-02
Beryllium	0.199	1.58E-08	6.30E-08	5.0E-03 [100]	none observed	3.15E-06	1.26E-05
Hazard Index:						5.56E-03	2.23E-02
Contaminated Soil Area							
Semivolatile Organics (μg/kg)							
Pentachlorophenol	6,310	4.99E-07	2.00E-06	3.0E-02 [100]	liver/kidney	1.66E-05	6.66E-05
Pesticides and PCBs (μg/kg)							
4,4'-DDT	84.6	6.70E-09	2.68E-08	5.0E-04 [100]	liver lesions	1.34E-05	5.36E-05
Inorganics (mg/kg)							
Antimony	25.9	2.05E-06	8.20E-06	4.0E-04 [1000]	blood chemistry	5.12E-03	2.05E-02
Arsenic	29.3	2.32E-06	9.28E-06	3.0E-04 [3]	skin	7.73E-03	3.09E-02
Barium	228	1.80E-05	7.22E-05	7.0E-02 [3]	increased BP	2.58E-04	1.03E-03
Cadmium	1.32	1.04E-07	4.18E-07	1.0E-03 [10]	kidney	1.04E-04	4.18E-04
Chromium	50.4	3.99E-06	1.60E-05	5.0E-03 [500]	CNS	7.98E-04	3.19E-03
Copper	1,310	1.04E-04	4.15E-04	3.7E-02 [1]	GI system	2.80E-03	1.12E-02
Manganese	478	3.78E-05	1.51E-04	7.0E-02 [3]	CNS	5.40E-04	2.16E-03
Mercury	0.703	5.56E-08	2.23E-07	3.0E-04 [1000]	kidney	1.85E-04	7.42E-04
Nickel	42.2	3.34E-06	1.34E-05	2.0E-02 [300]	low body weight	1.67E-04	6.68E-04
Zinc	613	4.85E-05	1.94E-04	3.0E-01 [3]	blood chemistry	1.62E-04	6.47E-04
Hazard Index:						1.79E-02	7.16E-02

Notes:
* = Maximum Detected Concentration.

TABLE 6-29. HAZARD INDEX FOR THE TRESPASSER RECEPTOR
FROM DERMAL CONTACT WITH SURFACE SOIL

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (ADD)	RME Case (ADD)	RfD	Absolute Oral Absorption Fraction [Uncertainty Factor]	Target Organ/Critical Effect	Adjusted RfD	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
B&M Railroad Landfill									
Inorganics (mg/kg)									
Cadmium	34.8 *	3.64E-07	4.52E-06	1.0E-03	0.05 [NA]	kidney	5.00E-05	7.27E-03	9.03E-02
Hazard Index:								7.27E-03	9.03E-02
Contaminated Soil Area									
Inorganics (mg/kg)									
Cadmium	1.32	1.38E-08	1.71E-07	1.0E-03	0.05 [NA]	kidney	5.00E-05	2.76E-04	3.43E-03
Hazard Index:								2.76E-04	3.43E-03

Notes:
* = Maximum Detected Concentration.

TABLE 6-30. HAZARD INDEX FOR THE TRESPASSER RECEPTOR FROM DERMAL CONTACT WITH AND INGESTION OF SURFACE SOIL

Location	ADD:RfD Ratio	
	Central Tendency	RME Case
B&M Railroad Landfill		
Ingestion of Surface Soil	2.31E-02	9.25E-02
Dermal Contact with Surface Soil	7.27E-03	9.03E-02
Hazard Index:	3.04E-02	1.83E-01
Contaminated Soil Area		
Ingestion of Surface Soil	1.79E-02	7.16E-02
Dermal Contact with Surface Soil	2.76E-04	3.43E-03
Hazard Index:	1.82E-02	7.50E-02

TABLE 6-31. INCREMENTAL LIFETIME CANCER RISK TO THE TRESPASSER RECEPTOR FROM INGESTION OF SEDIMENT

Carcinogenic Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (LADD)	RME Case (LADD)	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk	
						Central Tendency	RME Case
WEST MIDDLESEX CANAL AREA							
Semivolatile Analysis (µg/kg)							
Benzo(a)anthracene	2.60E+03 *	1.47E-08	1.18E-07	7.30E-01	B2	1.07E-08	8.58E-08
Benzo(b)fluoranthene	3.60E+03 *	2.04E-08	1.63E-07	7.30E-01	B2	1.49E-08	1.19E-07
Pesticide & PCB Analysis (µg/kg)							
PCBs	9.98E+02	5.64E-09	4.51E-08	1.0 or 2.0	B2	5.64E-09	9.03E-08
Inorganics (mg/kg)							
Arsenic	4.06E+01	2.30E-07	1.84E-06	1.50E+00	A	3.44E-07	2.75E-06
Beryllium	1.45E+00	8.20E-09	6.56E-08	4.30E+00	B2	3.52E-08	2.82E-07
Total:						4.11E-07	3.33E-06
CENTRAL WETLANDS AREA							
Semivolatile Analysis (µg/kg)							
Benzo(a)anthracene	2.98E+03	1.68E-08	1.35E-07	7.30E-01	B2	1.23E-08	9.84E-08
Benzo(a)pyrene	2.25E+03	1.27E-08	1.02E-07	7.30E+00	B2	9.29E-08	7.43E-07
Benzo(b)fluoranthene	3.29E+03	1.86E-08	1.49E-07	7.30E-01	B2	1.36E-08	1.09E-07
Dibenzo(a,h)anthracene	1.40E+02 *	7.91E-10	6.33E-09	7.30E+00	B2	5.78E-09	4.62E-08
Indeno(1,2,3-c,d)pyrene	2.44E+03	1.38E-08	1.10E-07	7.30E-01	B2	1.01E-08	8.06E-08
Pesticide & PCB Analysis (µg/kg)							
PCBs	6.56E+01	3.71E-10	2.97E-09	1.0 or 2.0	B2	3.71E-10	5.93E-09
Inorganics (mg/kg)							
Arsenic	2.11E+01	1.19E-07	9.54E-07	1.50E+00	A	1.79E-07	1.43E-06
Beryllium	1.28E+00	7.24E-09	5.79E-08	4.30E+00	B2	3.11E-08	2.49E-07
Total:						3.45E-07	2.76E-06
EAST MIDDLESEX CANAL AND WETLANDS AREA							
Semivolatile Analysis (µg/kg)							
Benzo(a)anthracene	5.39E+03	3.05E-08	2.44E-07	7.30E-01	B2	2.22E-08	1.78E-07
Benzo(a)pyrene	5.32E+03	3.01E-08	2.41E-07	7.30E+00	B2	2.20E-07	1.76E-06
Benzo(b)fluoranthene	5.74E+03	3.25E-08	2.60E-07	7.30E-01	B2	2.37E-08	1.90E-07
Benzo(k)fluoranthene	4.66E+03	2.63E-08	2.11E-07	7.30E-02	B2	1.92E-09	1.54E-08

TABLE 6-31 (Continued). INCREMENTAL LIFETIME CANCER RISK TO THE TRESPASSER RECEPTOR FROM INGESTION OF SEDIMENT

Carcinogenic Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (LADD)	RME Case (LADD)	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
Dibenzo(a,h)anthracene	2.89E+03	1.63E-08	1.31E-07	7.30E+00	B2	1.19E-07	9.54E-07
Indeno(1,2,3-c,d)pyrene	4.09E+03	2.31E-08	1.85E-07	7.30E-01	B2	1.69E-08	1.35E-07
Pesticide & PCB Analysis (μg/kg)							
PCBs	9.44E+01	5.34E-10	4.27E-09	1.0 or 2.0	B2	5.34E-10	8.54E-09
Inorganics (mg/kg)							
Arsenic	2.71E+01	1.53E-07	1.23E-06	1.50E+00	A	2.30E-07	1.84E-06
Beryllium	8.45E-01	4.78E-09	3.82E-08	4.30E+00	B2	2.05E-08	1.64E-07
Total:						6.54E-07	5.24E-06

Notes:

* = Maximum Detected Value.

TABLE 6-32. HAZARD INDEX FOR THE TRESPASSER RECEPTOR
FROM INGESTION OF SEDIMENT

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (ADD)	RME Case (ADD)	RfD [Uncertainty Factor]	Target Organ/Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
WEST MIDDLESEX CANAL AREA							
Inorganics (mg/kg)							
Arsenic	4.06E+01	3.21E-06	1.29E-05	3.0E-04 [3]	skin	1.07E-02	4.28E-02
Beryllium	1.45E+00	1.15E-07	4.59E-07	5.0E-03 [100]	none observed	2.30E-05	9.18E-05
Cadmium	1.46E+00	1.16E-07	4.62E-07	5.0E-04 [10]	kidney	2.31E-04	9.24E-04
Chromium	5.80E+01	4.59E-06	1.84E-05	5.0E-03 [500]	CNS	9.18E-04	3.67E-03
Manganese	9.95E+02	7.88E-05	3.15E-04	7.0E-02 [3]	CNS	1.13E-03	4.50E-03
Vanadium	3.83E+01	3.03E-06	1.21E-05	7.0E-03 [100]	none observed	4.33E-04	1.73E-03
Hazard Index:						1.34E-02	5.38E-02
CENTRAL WETLANDS AREA							
Inorganics (mg/kg)							
Antimony	1.65E+01	1.31E-06	5.22E-06	4.0E-04 [1,000]	blood chemistry	3.26E-03	1.31E-02
Arsenic	2.11E+01	1.67E-06	6.68E-06	3.0E-04 [3]	skin	5.57E-03	2.23E-02
Beryllium	1.28E+00	1.01E-07	4.05E-07	5.0E-03 [100]	none observed	2.03E-05	8.10E-05
Chromium	3.46E+01	2.74E-06	1.10E-05	5.0E-03 [500]	CNS	5.48E-04	2.19E-03
Copper	6.73E+02	5.33E-05	2.13E-04	3.7E-02 [1]	GI system	1.44E-03	5.76E-03
Manganese	4.91E+02	3.89E-05	1.55E-04	7.0E-02 [3]	CNS	5.55E-04	2.22E-03
Hazard Index:						1.14E-02	4.56E-02
EAST MIDDLESEX CANAL AND WETLANDS AREA							
Inorganics (mg/kg)							
Arsenic	2.71E+01	2.14E-06	8.58E-06	3.0E-04 [3]	skin	7.15E-03	2.86E-02
Beryllium	8.45E-01	6.69E-08	2.68E-07	5.0E-03 [100]	none observed	1.34E-05	5.35E-05
Chromium	1.46E+01	1.16E-06	4.62E-06	5.0E-03 [500]	CNS	2.31E-04	9.24E-04
Manganese	6.65E+02	5.26E-05	2.11E-04	7.0E-02 [3]	CNS	7.52E-04	3.01E-03
Vanadium	1.86E+01	1.47E-06	5.89E-06	7.0E-03 [100]	none observed	2.10E-04	8.41E-04
Hazard Index:						8.36E-03	3.34E-02

TABLE 6-33. HAZARD INDEX FOR THE TRESPASSER RECEPTOR
FROM DERMAL CONTACT WITH SEDIMENT

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (ADD)	RME Case (ADD)	RfD	Absolute Oral Absorption Fraction [Uncertainty Factor]	Target Organ/Critical Effect	Adjusted RfD	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
WEST MIDDLESEX CANAL AREA									
Inorganics (mg/kg)									
Cadmium	1.46E+00	1.53E-08	1.90E-07	5.0E-04	0.025 [NA]	kidney	1.25E-05	1.22E-03	1.52E-02
Hazard Index:								1.22E-03	1.52E-02

TABLE 6-34. HAZARD INDEX FOR THE TRESPASSER RECEPTOR FROM DERMAL CONTACT WITH AND INGESTION OF SEDIMENT

Location	ADD:RfD Ratio	
	Central Tendency	RME Case
WEST MIDDLESEX CANAL AREA		
Ingestion of Sediment	1.34E-02	5.38E-02
Dermal Contact with Sediment	1.22E-03	1.52E-02
Hazard Index:	1.47E-02	6.89E-02

TABLE 6-35. INCREMENTAL LIFETIME CANCER RISK TO THE TRESPASSER RECEPTOR FROM DERMAL CONTACT WITH SURFACE WATER

Carcinogenic Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case LADD	RME Case LADD	Slope Factor	Weight-of-Evidence Classification	Absolute Oral Absorption Fraction	Adjusted Slope Factor	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
West Middlesex Canal Area									
Pesticides and PCBs (ug/l)									
Heptachlor Epoxide	0.00156	5.60E-15	3.94E-14	9.1E+00	B2	0.78	1.2E+01	6.54E-14	4.59E-13
PCBs	0.0537	1.29E-10	9.09E-10	1.0 or 2.0	B2	0.93	1.1 or 2.2	1.38E-10	1.95E-09
Inorganics (ug/l)									
Arsenic	43.3 *	1.62E-08	1.61E-07	1.5E+00	A	1	1.5E+00	2.42E-08	2.41E-07
Total:								2.44E-08	2.43E-07
Central Wetlands Area									
Volatile Organics (ug/l)									
Methylene Chloride	5.38	1.51E-11	1.19E-10	7.5E-03	B2	0.98	7.7E-03	1.16E-13	9.14E-13
Tetrachloroethene	6.11	2.38E-09	1.67E-08	5.2E-02	B2/C	1	5.2E-02	1.24E-10	8.69E-10
Trichloroethene	5.44	1.04E-09	7.29E-09	1.1E-02	B2/C	0.98	1.1E-02	1.16E-11	8.18E-11
Semivolatile Organics (ug/l)									
Benzo(b)fluoranthene	1.0 *	2.29E-09	1.61E-08	7.3E-01	B2	1	7.3E-01	1.67E-09	1.18E-08
Inorganics (ug/l)									
Arsenic	18.8	7.01E-09	6.97E-08	1.5E+00	A	1	1.5E+00	1.05E-08	1.05E-07
Total:								1.23E-08	1.17E-07
East Middlesex Canal and Wetlands Area									
Volatile Organics (ug/l)									
Benzene	1.0 *	6.41E-11	4.67E-10	2.9E-02	A	0.8	3.6E-02	2.32E-12	1.69E-11
Chloromethane	3.0 *	6.66E-12	5.62E-11	1.3E-02	C	1	1.3E-02	8.65E-14	7.30E-13
Semivolatile Organics (ug/l)									
Benzo(a)anthracene	1.0 *	1.31E-09	9.22E-09	7.3E-01	B2	1	7.3E-01	9.57E-10	6.73E-09
Benzo(b)fluoranthene	2.0 *	4.59E-09	3.22E-08	7.3E-01	B2	1	7.3E-01	3.35E-09	2.35E-08
1,4-Dichlorobenzene	2.0 *	1.14E-10	8.26E-10	2.4E-02	C	1	2.4E-02	2.75E-12	1.98E-11
Pesticides and PCBs (ug/l)									
Aldrin	0.00191	1.27E-14	8.94E-14	1.7E+01	B2	1	1.7E+01	2.16E-13	1.52E-12
gamma-BHC	0.00332	1.33E-13	9.38E-13	1.3E+00	B2/C	0.99	1.3E+00	1.75E-13	1.23E-12
PCBs	0.0313	1.65E-10	1.16E-09	1.0 or 2.0	B2	0.93	1.1 or 2.2	1.76E-10	2.49E-09
Inorganics (ug/l)									
Arsenic	796	2.97E-07	2.95E-06	1.5E+00	A	1	1.5E+00	4.46E-07	4.43E-06
Beryllium	0.287	1.07E-10	1.06E-09	4.3E+00	B2	0.005	8.6E+02	9.21E-08	9.15E-07
Total:								4.50E-07	4.46E-06

Notes:

* Maximum detected concentration.

TABLE 6-36. HAZARD INDEX FOR THE TRESPASSER RECEPTOR FROM DERMAL CONTACT WITH SURFACE WATER

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case ADD	RME Case ADD	RfD	Target Organ/Critical Effect	Absolute Oral Absorption Fraction [Uncertainty Factor]	Adjusted RfD	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
West Middlesex Canal Area									
Pesticides and PCBs (ug/l)									
delta-BHC	0.00418	4.50E-12	1.58E-11	3.00E-04	liver/kidney	0.99 [1,000]	2.97E-04	1.51E-08	5.32E-08
Heptachlor Epoxide	0.00156	7.84E-14	2.76E-13	1.30E-05	liver	0.78 [1,000]	1.01E-05	7.74E-09	2.72E-08
Inorganics (ug/l)									
Arsenic	43.3 *	2.26E-07	1.12E-06	3.00E-04	skin	1 [3]	3.00E-04	7.54E-04	3.75E-03
Manganese	1,480	7.73E-06	3.84E-05	2.40E-02	CNS	0.055 [3]	1.32E-03	5.86E-03	2.91E-02
Thallium	2.01	1.05E-08	5.22E-08	8.00E-05	liver	1 [3,000]	8.00E-05	1.31E-04	6.52E-04
Total:								6.74E-03	3.48E-02
Central Wetlands Area									
Volatile Organics (ug/l)									
1,2-Dichloroethene(total)	5.79	5.37E-10	2.05E-09	9.00E-03	liver	1 [1,000]	9.00E-03	5.97E-08	2.28E-07
Methylene Chloride	5.38	2.12E-10	8.36E-10	6.00E-02	liver	0.98 [100]	5.88E-02	3.60E-09	1.42E-08
Tetrachloroethene	6.11	3.33E-08	1.17E-07	1.00E-02	liver	1 [1,000]	1.00E-02	3.33E-06	1.17E-05
Inorganics (ug/l)									
Arsenic	18.8	9.82E-08	4.88E-07	3.00E-04	skin	1 [3]	3.00E-04	3.27E-04	1.63E-03
Barium	88.7	4.63E-07	2.30E-06	7.00E-02	increased BP	0.05 [3]	3.50E-03	1.32E-04	6.58E-04
Cadmium	1.39	7.26E-09	3.61E-08	5.00E-04	kidney	0.025 [NA]	1.25E-05	5.81E-04	2.89E-03
Chromium	5.56	2.90E-08	1.44E-07	5.00E-03	CNS	0.1 [500]	5.00E-04	5.81E-05	2.89E-04
Copper	22.5	1.18E-07	5.84E-07	3.70E-02	GI system	0.97 [1]	3.59E-02	3.27E-06	1.63E-05
Manganese	1,510	7.89E-06	3.92E-05	2.40E-02	CNS	0.055 [3]	1.32E-03	5.98E-03	2.97E-02
Nickel	9.68	5.06E-08	2.51E-07	2.00E-02	low body weight	0.1 [300]	2.00E-03	2.53E-05	1.26E-04
Thallium	1.88	9.82E-09	4.88E-08	8.00E-05	liver	1 [3,000]	8.00E-05	1.23E-04	6.10E-04
Vanadium	3.82	2.00E-08	9.92E-08	7.00E-03	none observed	0.03 [100]	2.10E-04	9.50E-05	4.72E-04
Zinc	146	7.63E-07	3.79E-06	3.00E-01	blood chemistry	0.3 [3]	9.00E-02	8.47E-06	4.21E-05
Total:								7.35E-03	3.79E-02
East Middlesex Canal and Wetlands Area									
Semivolatile Organics (ug/l)									
4-Methylphenol	10.2	9.61E-10	3.66E-09	5.00E-03	CNS	1 [1,000]	5.00E-03	1.92E-07	7.32E-07

TABLE 6-36 (Continued). HAZARD INDEX FOR THE TRESPASSER RECEPTOR
FROM DERMAL CONTACT WITH SURFACE WATER

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case ADD	RME Case ADD	RfD	Target Organ/Critical Effect	Absolute Oral Absorption Fraction [Uncertainty Factor]	Adjusted RfD	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
Pesticides and PCBs (ug/l)									
Aldrin	0.00191	1.78E-13	6.26E-13	3.00E-05	liver	1 [1,000]	3.00E-05	5.94E-09	2.09E-08
gamma-BHC(Lindane)	0.00322	1.81E-12	6.37E-12	3.00E-04	liver/kidney	0.99 [1,000]	2.97E-04	6.10E-09	2.14E-08
Inorganics (ug/l)									
Antimony	9.61	5.02E-08	2.49E-07	4.00E-04	blood chemistry	0.1 [1,000]	4.00E-05	1.26E-03	6.24E-03
Arsenic	796	4.16E-06	2.07E-05	3.00E-04	skin	1 [3]	3.00E-04	1.39E-02	6.89E-02
Barium	465	2.43E-06	1.21E-05	7.00E-02	increased BP	0.05 [3]	3.50E-03	6.94E-04	3.45E-03
Beryllium	0.287	1.50E-09	7.45E-09	5.00E-03	none observed	0.005 [100]	2.50E-05	6.00E-05	2.98E-04
Chromium	9.52	4.97E-08	2.47E-07	5.00E-03	CNS	0.1 [500]	5.00E-04	9.95E-05	4.94E-04
Copper	10.4	5.43E-08	2.70E-07	3.70E-02	GI system	0.97 [1]	3.59E-02	1.51E-06	7.52E-06
Manganese	3010	1.57E-05	7.81E-05	2.40E-02	CNS	0.055 [3]	1.32E-03	1.19E-02	5.92E-02
Nickel	13.7	7.16E-08	3.56E-07	2.00E-02	low body weight	0.1 [300]	2.00E-03	3.58E-05	1.78E-04
Selenium	2.66	1.39E-08	6.91E-08	5.00E-03	selenosis	0.97 [3]	4.85E-03	2.86E-06	1.42E-05
Silver	4.29	2.24E-08	1.11E-07	5.00E-03	argyria	1 [3]	5.00E-03	4.48E-06	2.23E-05
Thallium	1.65	8.62E-09	4.28E-08	8.00E-05	liver	1 [3,000]	8.00E-05	1.08E-04	5.35E-04
Vanadium	15.4	8.04E-08	4.00E-07	7.00E-03	none observed	0.03 [100]	2.10E-04	3.83E-04	1.90E-03
Zinc	98.8	5.16E-07	2.56E-06	3.00E-01	blood chemistry	0.3 [3]	9.00E-02	5.73E-06	2.85E-05
Total:								3.10E-02	1.54E-01

Notes:

* Maximum detected concentration.

TABLE 6-37. INCREMENTAL LIFETIME CANCER RISK TO THE WORKER RECEPTOR FROM THE INGESTION OF SURFACE SOIL

Carcinogenic Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (LADD)	RME Case (LADD)	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
B&M Railroad Landfill							
Semivolatile Organics (μg/kg)							
Benzo(a)anthracene	11,100	6.98E-07	2.33E-06	7.3E-01	B2	5.10E-07	1.70E-06
Benzo(a)pyrene	11,300	7.11E-07	2.37E-06	7.3E+00	B2	5.19E-06	1.73E-05
Benzo(b)fluoranthene	26,400	1.66E-06	5.54E-06	7.3E-01	B2	1.21E-06	4.04E-06
Dibenzo(a,h)anthracene	4,200 *	2.64E-07	8.81E-07	7.3E+00	B2	1.93E-06	6.43E-06
Indeno(1,2,3-c,d)pyrene	8,410	5.29E-07	1.76E-06	7.3E-01	B2	3.86E-07	1.29E-06
Inorganics (mg/kg)							
Arsenic	27.0	1.70E-06	5.66E-06	1.5E+00	A	2.55E-06	8.49E-06
Total:						1.18E-05	3.92E-05
RSI Landfill							
Inorganics (mg/kg)							
Arsenic	4.77	3.00E-07	1.00E-06	1.5E+00	A	4.50E-07	1.50E-06
Total:						4.50E-07	1.50E-06
B&M Locomotive Shop Disposal Area							
Semivolatile Organics (μg/kg)							
Benzo(a)anthracene	2,300 *	1.45E-07	4.82E-07	7.3E-01	B2	1.06E-07	3.52E-07
Benzo(a)pyrene	1,700 *	1.07E-07	3.56E-07	7.3E+00	B2	7.81E-07	2.60E-06
Benzo(b)fluoranthene	2,900 *	1.82E-07	6.08E-07	7.3E-01	B2	1.33E-07	4.44E-07
Dibenzo(a,h)anthracene	366	2.30E-08	7.67E-08	7.3E+00	B2	1.68E-07	5.60E-07
Indeno(1,2,3-c,d)pyrene	920 *	5.79E-08	1.93E-07	7.3E-01	B2	4.22E-08	1.41E-07
Inorganics (mg/kg)							
Arsenic	49.3 *	3.10E-06	1.03E-05	1.5E+00	A	4.65E-06	1.55E-05
Beryllium	0.850 *	5.35E-08	1.78E-07	4.3E+00	B2	2.30E-07	7.66E-07
Total:						6.11E-06	2.04E-05

TABLE 6-37 (Continued). INCREMENTAL LIFETIME CANCER RISK TO THE WORKER RECEPTOR FROM THE INGESTION OF SURFACE SOIL

Carcinogenic Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (LADD)	RME Case (LADD)	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
Old B&M Oil/Sludge Recycling Area							
Inorganics (mg/kg)							
Arsenic	10.5	6.60E-07	2.20E-06	1.5E+00	A	9.91E-07	3.30E-06
Beryllium	0.199	1.25E-08	4.17E-08	4.3E+00	B2	5.38E-08	1.79E-07
Total:						1.04E-06	3.48E-06
Contaminated Soil Area							
Semivolatile Organics (μg/kg)							
Benzo(a)anthracene	2,530	1.59E-07	5.30E-07	7.3E-01	B2	1.16E-07	3.87E-07
Benzo(a)pyrene	2,530	1.59E-07	5.30E-07	7.3E+00	B2	1.16E-06	3.87E-06
Benzo(b)fluoranthene	3,960	2.49E-07	8.30E-07	7.3E-01	B2	1.82E-07	6.06E-07
Dibenzo(a,h)anthracene	1,960	1.23E-07	4.11E-07	7.3E+00	B2	9.00E-07	3.00E-06
Indeno(1,2,3-c,d)pyrene	2,160	1.36E-07	4.53E-07	7.3E-01	B2	9.92E-08	3.31E-07
Pentachlorophenol	6,310	3.97E-07	1.32E-06	1.2E-01	B2	4.76E-08	1.59E-07
Pesticides and PCBs (μg/kg)							
4,4'-DDT	84.6	5.32E-09	1.77E-08	3.4E-01	B2	1.81E-09	6.03E-09
Inorganics (mg/kg)							
Arsenic	29.3	1.84E-06	6.14E-06	1.5E+00	A	2.76E-06	9.22E-06
Total:						5.27E-06	1.76E-05

Notes:
* = Maximum Detected Concentration.

TABLE 6-38. HAZARD INDEX FOR THE WORKER RECEPTOR
FROM THE INGESTION OF SURFACE SOIL

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (ADD)	RME Case (ADD)	RfD [Uncertainty Factor]	Target Organ/Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
B&M Railroad Landfill							
Inorganics (mg/kg)							
Antimony	23.3	6.84E-06	1.37E-05	4.0E-04 [1000]	blood chemistry	1.71E-02	3.42E-02
Arsenic	27.0	7.93E-06	1.59E-05	3.0E-04 [3]	skin	2.64E-02	5.28E-02
Barium	744	2.18E-04	4.37E-04	7.0E-02 [3]	increased BP	3.12E-03	6.24E-03
Cadmium	34.8 *	1.02E-05	2.04E-05	1.0E-03 [10]	kidney	1.02E-02	2.04E-02
Chromium	201	5.90E-05	1.18E-04	5.0E-03 [500]	CNS	1.18E-02	2.36E-02
Copper	878	2.58E-04	5.15E-04	3.7E-02 [1]	GI system	6.97E-03	1.39E-02
Manganese	609	1.79E-04	3.58E-04	7.0E-02 [3]	CNS	2.55E-03	5.11E-03
Mercury	3.40 *	9.98E-07	2.00E-06	3.0E-04 [1000]	kidney	3.33E-03	6.65E-03
Zinc	4,400 *	1.29E-03	2.58E-03	3.0E-01 [3]	blood chemistry	4.31E-03	8.61E-03
Hazard Index:						8.58E-02	1.72E-01
RSI Landfill							
Inorganics (mg/kg)							
Arsenic	4.77	1.40E-06	2.80E-06	3.0E-04 [3]	skin	4.67E-03	9.33E-03
Manganese	197	5.78E-05	1.16E-04	7.0E-02 [3]	CNS	8.26E-04	1.65E-03
Hazard Index:						5.49E-03	1.10E-02
B&M Locomotive Shop Disposal Area							
Inorganics (mg/kg)							
Antimony	53.0 *	1.56E-05	3.11E-05	4.0E-04 [1000]	blood chemistry	3.89E-02	7.78E-02
Arsenic	49.3 *	1.45E-05	2.89E-05	3.0E-04 [3]	skin	4.82E-02	9.64E-02
Beryllium	0.850 *	2.50E-07	4.99E-07	5.0E-03 [100]	none observed	4.99E-05	9.98E-05
Chromium	87.4 *	2.57E-05	5.13E-05	5.0E-03 [500]	CNS	5.13E-03	1.03E-02
Copper	3,140 *	9.22E-04	1.84E-03	3.7E-02 [1]	GI system	2.49E-02	4.98E-02
Manganese	917 *	2.69E-04	5.38E-04	7.0E-02 [3]	CNS	3.85E-03	7.69E-03
Hazard Index:						1.21E-01	2.42E-01

TABLE 6-38 (Continued). HAZARD INDEX FOR THE WORKER RECEPTOR
FROM THE INGESTION OF SURFACE SOIL

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (ADD)	RME Case (ADD)	RfD [Uncertainty Factor]	Target Organ/Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
Old B&M Oil/Sludge Recycling Area							
Inorganics (mg/kg)							
Antimony	14.1 *	4.14E-06	8.28E-06	4.0E-04 [1000]	blood chemistry	1.03E-02	2.07E-02
Arsenic	10.5	3.08E-06	6.16E-06	3.0E-04 [3]	skin	1.03E-02	2.05E-02
Beryllium	0.199	5.84E-08	1.17E-07	5.0E-03 [100]	none observed	1.17E-05	2.34E-05
Hazard Index:						2.06E-02	4.13E-02
Contaminated Soil Area							
Semivolatile Organics (μg/kg)							
Pentachlorophenol	6,310	1.85E-06	3.70E-06	3.0E-02 [100]	liver/kidney	6.17E-05	1.23E-04
Pesticides and PCBs (μg/kg)							
4,4'-DDT	84.6	2.48E-08	4.97E-08	5.0E-04 [100]	liver lesions	4.97E-05	9.93E-05
Inorganics (mg/kg)							
Antimony	25.9	7.60E-06	1.52E-05	4.0E-04 [1000]	blood chemistry	1.90E-02	3.80E-02
Arsenic	29.3	8.60E-06	1.72E-05	3.0E-04 [3]	skin	2.87E-02	5.73E-02
Barium	228	6.69E-05	1.34E-04	7.0E-02 [3]	increased BP	9.56E-04	1.91E-03
Cadmium	1.32	3.87E-07	7.75E-07	1.0E-03 [10]	kidney	3.87E-04	7.75E-04
Chromium	50.4	1.48E-05	2.96E-05	5.0E-03 [500]	CNS	2.96E-03	5.92E-03
Copper	1,310	3.85E-04	7.69E-04	3.7E-02 [1]	GI system	1.04E-02	2.08E-02
Manganese	478	1.40E-04	2.81E-04	7.0E-02 [3]	CNS	2.00E-03	4.01E-03
Mercury	0.703	2.06E-07	4.13E-07	3.0E-04 [1000]	kidney	6.88E-04	1.38E-03
Nickel	42.2	1.24E-05	2.48E-05	2.0E-02 [300]	low body weight	6.19E-04	1.24E-03
Zinc	613	1.80E-04	3.60E-04	3.0E-01 [3]	blood chemistry	6.00E-04	1.20E-03
Hazard Index:						6.64E-02	1.33E-01

Notes:
* = Maximum Detected Concentration.

TABLE 6-39. HAZARD INDEX FOR THE WORKER RECEPTOR
FROM DERMAL CONTACT WITH SURFACE SOIL

Chemical	RME Exposure Point Concentration	Central Tendency Exposure Case (ADD)	RME Case (ADD)	RfD	Absolute Oral Absorption Fraction [Uncertainty Factor]	Target Organ/Critical Effect	Adjusted RfD	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME Case
B&M Railroad Landfill									
Inorganics (mg/kg)									
Cadmium	34.8 *	2.04E-06	1.18E-05	1.0E-03	0.05 [NA]	kidney	5.00E-05	4.09E-02	2.37E-01
Hazard Index:								4.09E-02	2.37E-01
Contaminated Soil Area									
Inorganics (mg/kg)									
Cadmium	1.32	7.75E-08	4.49E-07	1.0E-03	0.05 [NA]	kidney	5.00E-05	1.55E-03	8.99E-03
Hazard Index:								1.55E-03	8.99E-03

Notes:
* = Maximum Detected Concentration.
NA = not available

TABLE 6-40. HAZARD INDEX FOR THE WORKER RECEPTOR
FROM DERMAL CONTACT WITH AND INGESTION OF SURFACE SOIL

Location	ADD:RfD Ratio	
	Central Tendency	RME Case
B&M Railroad Landfill		
Ingestion of Surface Soil	8.58E-02	1.72E-01
Dermal Contact with Surface Soil	4.09E-02	2.37E-01
Hazard Index:	1.27E-01	4.09E-01
Contaminated Soil Area		
Ingestion of Surface Soil	6.64E-02	1.33E-01
Dermal Contact with Surface Soil	1.55E-03	8.99E-03
Hazard Index:	6.79E-02	1.42E-01

TABLE 6-41. INCREMENTAL LIFETIME CANCER RISK TO THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER [FUTURE USE SCENARIO]

	Exposure Point Concentration		Exposure Case LADD				Incremental Lifetime Cancer Risk	
Carcinogenic Chemical	Central Tendency	RME	Central Tendency	RME	Slope Factor	Weight-of-Evidence Classification	Central Tendency	RME Case
B&M Railroad Landfill - Shallow Overburden								
Semivolatile Organics (μg/l)								
Carbazole	4.90E+00	6.00E+00 *	1.21E-05	7.05E-05	2.0E-02	B2	2.42E-07	1.41E-06
Pesticides and PCBs (μg/l)								
Aldrin	2.55E-03	1.00E-02 *	6.29E-09	1.17E-07	1.7E+01	B2	1.07E-07	2.00E-06
PCBs	4.95E-02	1.50E-01 *	1.22E-07	1.76E-06	1.0 or 2.0	B2	1.22E-07	3.52E-06
Inorganics (μg/l)								
Arsenic	1.18E+01	5.56E+01 *	2.91E-05	6.53E-04	1.5E+00	A	4.36E-05	9.79E-04
Total:							4.41E-05	***9.86E-04***
B&M Railroad Landfill - Deep Overburden								
Volatile Organics (μg/l)								
1,2-Dichloroethane	3.00E+00 *	3.00E+00 *	7.40E-06	3.52E-05	9.1E-02	B2	6.73E-07	3.21E-06
1,1-Dichloroethene	5.12E+00	7.50E+00 *	1.26E-05	8.81E-05	6.0E-01	C	7.57E-06	5.28E-05
Trichloroethene	1.18E+01	5.30E+01 *	2.91E-05	6.22E-04	1.1E-02	B2/C	3.20E-07	6.85E-06
Pesticides and PCBs (μg/l)								
PCBs	2.00E-02 *	2.00E-02 *	4.93E-08	2.35E-07	1.0 or 2.0	B2	4.93E-08	4.70E-07
Total:							8.62E-06	6.34E-05
B&M Railroad Landfill - Bedrock								
Volatile Organics (μg/l)								
Chloroform	4.70E+00	6.00E+00 *	1.16E-05	7.05E-05	6.1E-03	B2	7.07E-08	4.30E-07
1,2-Dichloroethane	5.90E+00	9.00E+00 *	1.45E-05	1.06E-04	9.1E-02	B2	1.32E-06	9.62E-06
1,1-Dichloroethene	5.10E+00	9.00E+00 *	1.26E-05	1.06E-04	6.0E-01	C	7.55E-06	6.34E-05
Trichloroethene	1.66E+01	5.00E+01 *	4.09E-05	5.87E-04	1.1E-02	B2/C	4.50E-07	6.46E-06
Semivolatile Organics (μg/l)								
Bis(2-ethylhexyl)phthalate	6.15E+00	9.00E+00 *	1.52E-05	1.06E-04	1.4E-02	B2	2.12E-07	1.48E-06
Inorganics (μg/l)								
Arsenic	6.82E+00	1.96E+01 *	1.68E-05	2.30E-04	1.5E+00	A	2.52E-05	3.45E-04
Total:							3.48E-05	***4.27E-04***

TABLE 6-41 (continued). INCREMENTAL LIFETIME CANCER RISK TO THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER
[FUTURE USE SCENARIO]

Carcinogenic Chemical	Exposure Point Concentration: Central Tendency	Exposure Point Concentration: RME	Exposure Case LADD: Central Tendency	Exposure Case LADD: RME	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
RSI Landfill - Shallow Overburden								
Volatile Organics (µg/l)								
Benzene	5.39E+01	3.50E+02 *	1.33E-04	4.11E-03	2.9E-02	A	3.85E-06	1.19E-04
Semivolatile Organics (µg/l)								
1,4-Dichlorobenzene	3.00E+00 *	3.00E+00 *	7.40E-06	3.52E-05	2.4E-02	C	1.78E-07	8.45E-07
Pesticides and PCBs (µg/l)								
beta-BHC	4.29E-03	4.00E-02 *	1.06E-08	4.70E-07	1.8E+00	C	1.90E-08	8.45E-07
PCBs	1.00E-02 *	1.00E-02 *	2.47E-08	1.17E-07	1.0 or 2.0	B2	2.47E-08	2.35E-07
Inorganics (µg/l)								
Arsenic	3.95E+01	1.86E+02 *	9.74E-05	2.18E-03	1.5E+00	A	1.46E-04	3.28E-03
Total:							***1.50E-04***	***3.40E-03***
RSI Landfill - Deep Overburden								
Volatile Organics (µg/l)								
1,1,2,2-Tetrachloroethane	5.00E+00	5.00E+00 *	1.23E-05	5.87E-05	2.0E-01	C	2.47E-06	1.17E-05
Trichloroethene	8.40E+00	2.30E+01 *	2.07E-05	2.70E-04	1.1E-02	B2/C	2.28E-07	2.97E-06
Pesticides and PCBs (µg/l)								
PCBs	3.07E-02	8.00E-02 *	7.57E-08	9.39E-07	1.0 or 2.0	B2	7.57E-08	1.88E-06
Inorganics (µg/l)								
Arsenic	6.85E+01	3.45E+02 *	1.69E-04	4.05E-03	1.5E+00	A	2.53E-04	6.08E-03
Total:							***2.56E-04***	***6.09E-03***
RSI Landfill - Bedrock								
Volatile Organics (µg/l)								
1,2-Dichloroethane	4.45E+00	6.00E+00 *	1.10E-05	7.05E-05	9.1E-02	B2	9.99E-07	6.41E-06
1,1-Dichloroethene	2.00E+00 *	2.00E+00 *	4.93E-06	2.35E-05	6.0E-01	C	2.96E-06	1.41E-05
Tetrachloroethene	3.00E+00 *	3.00E+00 *	7.40E-06	3.52E-05	5.2E-02	B2/C	3.85E-07	1.83E-06
Trichloroethene	4.60E+00	5.00E+00 *	1.13E-05	5.87E-05	1.1E-02	B2/C	1.25E-07	6.46E-07
Pesticides and PCBs (µg/l)								
Heptachlor Epoxide	1.70E-03	2.00E-03 *	4.19E-09	2.35E-08	9.1E+00	B2	3.81E-08	2.14E-07
PCBs	3.20E-02	8.00E-02 *	7.89E-08	9.39E-07	1.0 or 2.0	B2	7.89E-08	1.88E-06

TABLE 6-41 (continued). INCREMENTAL LIFETIME CANCER RISK TO THE RESIDENT RECEPTOR
FROM THE INGESTION OF GROUNDWATER
[FUTURE USE SCENARIO]

Carcinogenic Chemical	Exposure Point Concentration: Central Tendency	Exposure Point Concentration: RME	Exposure Case LADD: Central Tendency	Exposure Case LADD: RME	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
Inorganics (μg/l)								
Arsenic	5.28E+00	1.19E+01 *	1.30E-05	1.40E-04	1.5E+00	A	1.95E-05	2.10E-04
Total:							***2.41E-05***	***2.35E-04***
B&M Locomotive Shop Disposal Area - Shallow Overburden								
Volatile Organics (μg/l)								
1,2-Dichloroethane	3.00E+00 *	3.00E+00 *	7.40E-06	3.52E-05	9.1E-02	B2	6.73E-07	3.21E-06
1,1,2,2-Tetrachloroethane	3.00E+00 *	3.00E+00 *	7.40E-06	3.52E-05	2.0E-01	C	1.48E-06	7.05E-06
Pesticides and PCBs (mg/l)								
Heptachlor Epoxide	1.69E-03	3.00E-03 *	4.17E-09	3.52E-08	9.1E+00	B2	3.79E-08	3.21E-07
Inorganics (μg/l)								
Arsenic	3.04E+00	4.30E+00 *	7.50E-06	5.05E-05	1.5E+00	A	1.12E-05	7.57E-05
Total:							1.34E-05	8.63E-05
B&M Locomotive Shop Disposal Area - Deep Overburden								
Pesticides and PCBs (μg/l)								
PCBs	9.00E-03 *	9.00E-03 *	2.22E-08	1.06E-07	1.0 or 2.0	B2	2.22E-08	2.11E-07
Inorganics (μg/l)								
Arsenic	5.56E+00	1.66E+01 *	1.37E-05	1.95E-04	1.5E+00	A	2.06E-05	2.92E-04
Total:							2.06E-05	***2.93E-04***
B&M Locomotive Shop Disposal Area - Bedrock								
Pesticides and PCBs (μg/l)								
PCBs	1.00E-02 *	1.00E-02 *	2.47E-08	1.17E-07	1.0 or 2.0	B2	2.47E-08	2.35E-07
Inorganics (μg/l)								
Arsenic	3.30E+00	5.10E+00 *	8.14E-06	5.99E-05	1.5E+00	A	1.22E-05	8.98E-05
Total:							1.22E-05	9.01E-05
Old B&M Oil/Sludge Recycling Area - Shallow Overburden								
Semivolatile Organics (μg/l)								
Bis(2-ethylhexyl)phthalate	4.83E+00	5.00E+00 *	1.19E-05	5.87E-05	1.4E-02	B2	1.67E-07	8.22E-07
Pesticides and PCBs (μg/l)								
PCBs	2.00E-02 *	2.00E-02 *	4.93E-08	2.35E-07	1.0 or 2.0	B2	4.93E-08	4.70E-07

TABLE 6-41 (continued). INCREMENTAL LIFETIME CANCER RISK TO THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER [FUTURE USE SCENARIO]

Carcinogenic Chemical	Exposure Point Concentration		Exposure Case LADD		Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk	
	Central Tendency	RME	Central Tendency	RME			Central Tendency	RME Case
Inorganics (µg/l)								
Arsenic	7.43E+00	2.71E+01 *	1.83E-05	3.18E-04	1.5E+00	A	2.75E-05	4.77E-04
Total:							2.77E-05	***4.79E-04***
Old B&M Oil/Sludge Recycling Area - Deep Overburden								
Pesticides and PCBs (µg/l)								
Heptachlor Epoxide	1.51E-03	2.00E-03 *	3.72E-09	2.35E-08	9.1E+00	B2	3.39E-08	2.14E-07
Inorganics (µg/l)								
Arsenic	3.60E+00	7.40E+00 *	8.88E-06	8.69E-05	1.5E+00	A	1.33E-05	1.30E-04
Total:							1.33E-05	***1.31E-04***
Old B&M Oil/Sludge Recycling Area - Bedrock								
Volatile Organics (µg/l)								
Chloroform	3.00E+00 *	3.00E+00 *	7.40E-06	3.52E-05	6.1E-03	B2	4.51E-08	2.15E-07
Inorganics (µg/l)								
Arsenic	4.23E+00	9.60E+00 *	1.04E-05	1.13E-04	1.5E+00	A	1.56E-05	1.69E-04
Total:							1.57E-05	***1.69E-04***
Asbestos Lagoons - Shallow Overburden								
Volatile Organics (µg/l)								
1,1,2,2-Tetrachloroethane	3.00E+00 *	3.00E+00 *	7.40E-06	3.52E-05	2.0E-01	C	1.48E-06	7.05E-06
Inorganics (µg/l)								
Arsenic	1.84E+01	5.81E+01 *	4.54E-05	6.82E-04	1.5E+00	A	6.81E-05	1.02E-03
Total:							6.95E-05	***1.03E-03***
Asbestos Lagoons - Deep Overburden								
Volatile Organics (µg/l)								
1,2-Dichloroethane	3.00E+00 *	3.00E+00 *	7.40E-06	3.52E-05	9.1E-02	B2	6.73E-07	3.21E-06
Semivolatile Organics (µg/l)								
Bis(2-ethylhexyl)phthalate	5.75E+00	1.30E+01 *	1.42E-05	1.53E-04	1.4E-02	B2	1.98E-07	2.14E-06
Pesticides and PCBs (µg/l)								
Heptachlor Epoxide	2.31E-03	5.00E-03 *	5.70E-09	5.87E-08	9.1E+00	B2	5.18E-08	5.34E-07

TABLE 6-41 (continued). INCREMENTAL LIFETIME CANCER RISK TO THE RESIDENT RECEPTOR
FROM THE INGESTION OF GROUNDWATER
[FUTURE USE SCENARIO]

Carcinogenic Chemical	Exposure Point Concentration: Central Tendency	Exposure Point Concentration: RME		Exposure Case LADD: Central Tendency	Exposure Case LADD: RME	Slope Factor	Weight-of-Evidence Classification	Incremental Lifetime Cancer Risk: Central Tendency	Incremental Lifetime Cancer Risk: RME Case
Inorganics (µg/l)									
Arsenic	5.67E+00	1.73E+01	*	1.40E-05	2.03E-04	1.5E+00	A	2.10E-05	3.05E-04
Beryllium	6.34E-01	2.40E+00	*	1.56E-06	2.82E-05	4.3E+00	B2	6.72E-06	1.21E-04
Total:								2.86E-05	***4.32E-04***
Asbestos Lagoons - Bedrock									
Volatile Organics (µg/l)									
1,2-Dichloroethane	1.54E+01	3.90E+01	*	3.80E-05	4.58E-04	9.1E-02	B2	3.46E-06	4.17E-05
Semivolatile Organics (µg/l)									
Bis(2-ethylhexyl)phthalate	7.00E+00	1.70E+01	*	1.73E-05	2.00E-04	1.4E-02	B2	2.42E-07	2.79E-06
Pesticides and PCBs (µg/l)									
Heptachlor Epoxide	2.25E-03	5.00E-03	*	5.55E-09	5.87E-08	9.1E+00	B2	5.05E-08	5.34E-07
PCBs	6.17E-02	1.00E-01	*	1.52E-07	1.17E-06	1.0 or 2.0	B2	1.52E-07	2.35E-06
Inorganics (µg/l)									
Beryllium	7.00E-01	2.10E+00	*	1.73E-06	2.47E-05	4.3E+00	B2	7.42E-06	1.06E-04
Total:								1.13E-05	***1.53E-04***

NOTES:
* = Maximum Detected Concentration.

TABLE 6-42. HAZARD INDEX FOR THE RESIDENT RECEPTOR
FROM THE INGESTION OF GROUNDWATER
[FUTURE USE SCENARIO]

	Exposure Point Concentration		Exposure Case ADD				ADD:RfD Ratio	
Chemical	**Central Tendency**	**RME**	**Central Tendency**	**RME**	**RfD**	**Target Organ/ Critical Effect**	**Central Tendency**	**RME**
B&M Railroad Landfill - Shallow Overburden								
Semivolatile Organics (μg/l)								
4-Methylphenol	8.10	37 *	1.55E-04	1.01E-03	5.0E-03	CNS	3.11E-02	2.03E-01
Pesticides and PCBs (μg/l)								
Aldrin	0.00255	0.01 *	4.89E-08	2.74E-07	3.0E-05	liver	1.63E-03	9.13E-03
Inorganics (μg/l)								
Antimony	1.73	4.70 *	3.32E-05	1.29E-04	4.0E-04	blood chemistry	8.29E-02	3.22E-01
Arsenic	11.8	55.6 *	2.26E-04	1.52E-03	3.0E-04	skin	7.54E-01	5.08E+00
Barium	374	2000 *	7.17E-03	5.48E-02	7.0E-02	increased BP	1.02E-01	7.83E-01
Manganese	1230	5420 *	2.36E-02	1.48E-01	2.4E-02	CNS	9.83E-01	6.19E+00
Total:							***1.96E+00***	***1.26E+01***
B&M Railroad Landfill - Deep Overburden								
Volatile Organics (μg/l)								
Chlorobenzene	4.0 *	4.0 *	7.67E-05	1.10E-04	2.0E-02	liver	3.84E-03	5.48E-03
1,1-Dichloroethene	5.12	7.5 *	9.82E-05	2.05E-04	9.0E-03	liver	1.09E-02	2.28E-02
Inorganics (μg/l)								
Manganese	405	922 *	7.77E-03	2.53E-02	2.4E-02	CNS	3.24E-01	1.05E+00
Total:							3.38E-01	***1.08E+00***
B&M Railroad Landfill - Bedrock								
Volatile Organics (μg/l)								
Chloroform	4.70	6.0 *	9.01E-05	1.64E-04	1.0E-02	liver	9.01E-03	1.64E-02
1,1-Dichloroethene	5.10	9.0 *	9.78E-05	2.47E-04	9.0E-03	liver	1.09E-02	2.74E-02
1,2-Dichloroethene(total)	4.90	9.0 *	9.40E-05	2.47E-04	9.0E-03	liver	1.04E-02	2.74E-02
Semivolatile Organics (μg/l)								
Bis(2-ethylhexyl)phthalate	6.15	9.0 *	1.18E-04	2.47E-04	2.0E-02	liver	5.90E-03	1.23E-02
Inorganics (μg/l)								
Arsenic	6.82	19.6 *	1.31E-04	5.37E-04	3.0E-04	skin	4.36E-01	1.79E+00
Manganese	295	1260 *	5.66E-03	3.45E-02	2.4E-02	CNS	2.36E-01	1.44E+00
Total:							7.08E-01	***3.31E+00***

TABLE 6-42 (continued). HAZARD INDEX FOR THE RESIDENT RECEPTOR
FROM THE INGESTION OF GROUNDWATER
[FUTURE USE SCENARIO]

Chemical	Exposure Point Concentration		Exposure Case ADD				ADD:RfD Ratio	
	Central Tendency	RME	Central Tendency	RME	RfD	Target Organ/ Critical Effect	Central Tendency	RME
RSI Landfill - Shallow Overburden								
Inorganics (µg/l)								
Arsenic	39.5	186 *	7.58E-04	5.10E-03	3.0E-04	skin	2.53E+00	1.70E+01
Manganese	966	2440 *	1.85E-02	6.68E-02	2.4E-02	CNS	7.72E-01	2.79E+00
Total:							***3.30E+00***	***1.98E+01***
RSI Landfill - Deep Overburden								
Volatile Organics (µg/l)								
1,2-Dichloroethene(total)	5.2	8.0 *	9.97E-05	2.19E-04	9.0E-03	liver	1.11E-02	2.44E-02
Inorganics (µg/l)								
Arsenic	68.5	345 *	1.31E-03	9.45E-03	3.0E-04	skin	4.38E+00	3.15E+01
Barium	115	419 *	2.21E-03	1.15E-02	7.0E-02	increased BP	3.15E-02	1.64E-01
Cadmium	0.800	2.0 *	1.53E-05	5.48E-05	5.0E-04	kidney	3.07E-02	1.10E-01
Chromium	3.27	20.6 *	6.27E-05	5.64E-04	5.0E-03	CNS	1.25E-02	1.13E-01
Cyanide	35.6	208 *	6.83E-04	5.70E-03	2.0E-02	CNS	3.41E-02	2.85E-01
Manganese	2770	6400 *	5.31E-02	1.75E-01	2.4E-02	CNS	2.21E+00	7.31E+00
Thallium	3.89	9.0 *	7.46E-05	2.47E-04	8.0E-05	liver	9.33E-01	3.08E+00
Total:							***7.64E+00***	***4.26E+01***
RSI Landfill - Bedrock								
Volatile Organics (µg/l)								
1,1-Dichloroethene	2.0 *	2.0 *	3.84E-05	5.48E-05	9.0E-03	liver	4.26E-03	6.09E-03
Tetrachloroethene	3.0 *	3.0 *	5.75E-05	8.22E-05	1.0E-02	liver	5.75E-03	8.22E-03
Pesticides and PCBs (µg/l)								
Heptachlor Epoxide	0.00170	0.0020 *	3.26E-08	5.48E-08	1.3E-05	liver	2.51E-03	4.21E-03
Inorganics (µg/l)								
Arsenic	5.28	11.9 *	1.01E-04	3.26E-04	3.0E-04	skin	3.38E-01	1.09E+00
Cyanide	46.5	189 *	8.92E-04	5.16E-03	2.0E-02	CNS	4.46E-02	2.58E-01
Manganese	589	2690 *	1.13E-02	7.37E-02	2.4E-02	CNS	4.71E-01	3.07E+00
Silver	6.04	27.4 *	1.16E-04	7.51E-04	5.0E-03	argyria	2.32E-02	1.50E-01
Total:							8.88E-01	***4.58E+00***

TABLE 6-42 (continued). HAZARD INDEX FOR THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER [FUTURE USE SCENARIO]

Chemical	Exposure Point Concentration Central Tendency	Exposure Point Concentration RME		Exposure Case ADD Central Tendency	Exposure Case ADD RME	RfD	Target Organ/ Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME
B&M Locomotive Shop Disposal Area - Shallow Overburden									
Pesticides and PCBs (µg/l)									
Heptachlor Epoxide	0.00169	0.003	*	3.24E-08	8.22E-08	1.3E-05	liver	2.49E-03	6.32E-03
Inorganics (µg/l)									
Arsenic	3.04	4.3	*	5.83E-05	1.18E-04	3.0E-04	skin	1.94E-01	3.93E-01
Manganese	2295	11,000	*	4.40E-02	3.01E-01	2.4E-02	CNS	1.83E+00	1.26E+01
Total:								***2.03E+00***	***1.30E+01***
B&M Locomotive Shop Disposal Area - Deep Overburden									
Inorganics (µg/l)									
Arsenic	5.56	16.6	*	1.07E-04	4.55E-04	3.0E-04	skin	3.55E-01	1.52E+00
Manganese	160	829	*	3.07E-03	2.27E-02	2.4E-02	CNS	1.28E-01	9.46E-01
Total:								4.83E-01	***2.46E+00***
B&M Locomotive Shop Disposal Area - Bedrock									
Inorganics (µg/l)									
Arsenic	3.3	5.1	*	6.33E-05	1.40E-04	3.0E-04	skin	2.11E-01	4.66E-01
Manganese	270	519	*	5.18E-03	1.42E-02	2.4E-02	CNS	2.16E-01	5.92E-01
Total:								4.27E-01	***1.06E+00***
Old B&M Oil/Sludge Recycling Area - Shallow Overburden									
Semivolatile Organics (µg/l)									
Bis(2-ethylhexyl)phthalate	4.83	5	*	9.26E-05	1.37E-04	2.0E-02	liver	4.63E-03	6.85E-03
Inorganics (µg/l)									
Arsenic	7.43	27.1	*	1.42E-04	7.42E-04	3.0E-04	skin	4.75E-01	2.47E+00
Manganese	541	1,480	*	1.04E-02	4.05E-02	2.4E-02	CNS	4.32E-01	1.69E+00
Total:								9.12E-01	***4.17E+00***
Old B&M Oil/Sludge Recycling Area - Deep Overburden									
Pesticides and PCBs (µg/l)									
Heptachlor Epoxide	0.00151	0.002	*	2.90E-08	5.48E-08	1.3E-05	liver	2.23E-03	4.21E-03
Inorganics (µg/l)									
Arsenic	3.6	7.4	*	6.90E-05	2.03E-04	3.0E-04	skin	2.30E-01	6.76E-01

TABLE 6-42 (continued). HAZARD INDEX FOR THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER [FUTURE USE SCENARIO]

Chemical	Exposure Point Concentration Central Tendency	Exposure Point Concentration RME	Exposure Case ADD Central Tendency	Exposure Case ADD RME	RfD	Target Organ/ Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME
Manganese	455	1,370 *	8.73E-03	3.75E-02	2.4E-02	CNS	3.64E-01	1.56E+00
Total:							5.94E-01	***2.24E+00***
Old B&M Oil/Sludge Recycling Area - Bedrock								
Volatile Organics (µg/l)								
Chloroform	3.0 *	3.0 *	5.75E-05	8.22E-05	1.0E-02	liver	5.75E-03	8.22E-03
Inorganics (µg/l)								
Arsenic	4.23	9.6 *	8.11E-05	2.63E-04	3.0E-04	skin	2.70E-01	8.77E-01
Manganese	334	1370 *	6.41E-03	3.75E-02	2.4E-02	CNS	2.67E-01	1.56E+00
Nickel	14.5	112 *	2.78E-04	3.07E-03	2.0E-02	low body weight	1.39E-02	1.53E-01
Total:							5.57E-01	***2.60E+00***
Asbestos Lagoons - Shallow Overburden								
Inorganics (µg/l)								
Arsenic	18.4	58.1 *	3.53E-04	1.59E-03	3.0E-04	skin	1.18E+00	5.31E+00
Manganese	516	1020 *	9.90E-03	2.79E-02	2.4E-02	CNS	4.12E-01	1.16E+00
Total:							***1.59E+00***	***6.47E+00***
Asbestos Lagoons - Deep Overburden								
Semivolatile Organics (µg/l)								
Bis(2-ethylhexyl)phthalate	5.75	13 *	1.10E-04	3.56E-04	2.0E-02	liver	5.51E-03	1.78E-02
Pesticides and PCBs (µg/l)								
Heptachlor Epoxide	0.00231	0.0050 *	4.43E-08	1.37E-07	1.3E-05	liver	3.41E-03	1.05E-02
Inorganics (µg/l)								
Arsenic	5.67	17.3 *	1.09E-04	4.74E-04	3.0E-04	skin	3.62E-01	1.58E+00
Beryllium	0.634	2.40 *	1.22E-05	6.58E-05	5.0E-03	none observed	2.43E-03	1.32E-02
Manganese	2410	4160 *	4.62E-02	1.14E-01	2.4E-02	CNS	1.93E+00	4.75E+00
Total:							***2.30E+00***	***6.37E+00***
Asbestos Lagoons - Bedrock								
Semivolatile Organics (µg/l)								
Bis(2-ethylhexyl)phthalate	7.0	17 *	1.34E-04	4.66E-04	2.0E-02	liver	6.71E-03	2.33E-02

TABLE 6-42 (continued). HAZARD INDEX FOR THE RESIDENT RECEPTOR
FROM THE INGESTION OF GROUNDWATER
[FUTURE USE SCENARIO]

Chemical	Exposure Point Concentration Central Tendency	Exposure Point Concentration RME	Exposure Case ADD Central Tendency	Exposure Case ADD RME	RfD	Target Organ/ Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME
Pesticides and PCBs (μg/l)								
Heptachlor Epoxide	0.00225	0.005 *	4.32E-08	1.37E-07	1.3E-05	liver	3.32E-03	1.05E-02
Inorganics (μg/l)								
Beryllium	0.700	2.10 *	1.34E-05	5.75E-05	5.0E-03	none observed	2.68E-03	1.15E-02
Cadmium	0.925	2.05 *	1.77E-05	5.62E-05	5.0E-04	kidney	3.55E-02	1.12E-01
Manganese	3200	8745 *	6.14E-02	2.40E-01	2.4E-02	CNS	2.56E+00	9.98E+00
Nickel	38.8	122 *	7.44E-04	3.33E-03	2.0E-02	low body weight	3.72E-02	1.66E-01
Total:							***2.64E+00***	***1.03E+01***

NOTES:
* = Maximum Detected Concentration.

TABLE 6-43. HAZARD INDEX FOR THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER, SUMMED BY EFFECT [FUTURE USE SCENARIO]

	Exposure Point Concentration		Exposure Case ADD				ADD:RfD Ratio	
Chemical	Central Tendency	RME	Central Tendency	RME	RfD	Target Organ/ Critical Effect	Central Tendency	RME
B&M Railroad Landfill - Shallow Overburden								
Antimony	1.73	4.70 *	3.32E-05	1.29E-04	4.00E-04	blood chemistry	8.29E-02	3.22E-01
4-Methylphenol	8.10	37 *	1.55E-04	1.01E-03	5.00E-03	CNS	3.11E-02	2.03E-01
Manganese	1230	5420 *	2.36E-02	1.48E-01	2.40E-02	CNS	9.83E-01	6.19E+00
						Total CNS	***1.01E+00***	***6.39E+00***
Barium	374	2000 *	7.17E-03	5.48E-02	7.00E-02	increased BP	1.02E-01	7.83E-01
Aldrin	0.00255	0.010 *	4.89E-08	2.74E-07	3.00E-05	liver	1.63E-03	9.13E-03
Arsenic	11.8	55.6 *	2.26E-04	1.52E-03	3.00E-04	skin	7.54E-01	5.08E+00
						Total Overall	***1.96E+00***	***1.26E+01***
B&M Railroad Landfill - Deep Overburden								
Chlorobenzene	4.0 *	4.0 *	7.67E-05	1.10E-04	2.00E-02	liver	3.84E-03	5.48E-03
1,1-Dichloroethene	5.12	7.5 *	9.82E-05	2.05E-04	9.00E-03	liver	1.09E-02	2.28E-02
						Total liver	1.47E-02	2.83E-02
Manganese	405	922 *	7.77E-03	2.53E-02	2.40E-02	CNS	3.24E-01	1.05E+00
						Total Overall	3.38E-01	***1.08E+00***
B&M Railroad Landfill - Bedrock								
Chloroform	4.70	6.0 *	9.01E-05	1.64E-04	1.00E-02	liver	9.01E-03	1.64E-02
1,1-Dichloroethene	5.10	9.0 *	9.78E-05	2.47E-04	9.00E-03	liver	1.09E-02	2.74E-02
1,2-Dichloroethene(total)	4.90	9.0 *	9.40E-05	2.47E-04	9.00E-03	liver	1.04E-02	2.74E-02
Bis(2-ethylhexyl)phthalate	6.15	9.0 *	1.18E-04	2.47E-04	2.00E-02	liver	5.90E-03	1.23E-02
						Total liver	3.62E-02	8.36E-02
Arsenic	6.82	19.6 *	1.31E-04	5.37E-04	3.00E-04	skin	4.36E-01	1.79E+00
Manganese	295	1260 *	5.66E-03	3.45E-02	2.40E-02	CNS	2.36E-01	1.44E+00
						Total Overall	7.08E-01	***3.31E+00***

TABLE 6-43 (continued). HAZARD INDEX FOR THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER, SUMMED BY EFFECT [FUTURE USE SCENARIO]

Chemical	Exposure Point Concentration		Exposure Case ADD		RfD	Target Organ/ Critical Effect	ADD:RfD Ratio	
	Central Tendency	RME	Central Tendency	RME			Central Tendency	RME
RSI Landfill - Shallow Overburden								
Arsenic	39.5	186 *	7.58E-04	5.10E-03	3.00E-04	skin	2.53E+00	1.70E+01
Manganese	966	2440 *	1.85E-02	6.68E-02	2.40E-02	CNS	7.72E-01	2.79E+00
						Total Overall	***3.30E+00***	***1.98E+01***
RSI Landfill - Deep Overburden								
Chromium	3.27	20.6 *	6.27E-05	5.64E-04	5.00E-03	CNS	1.25E-02	1.13E-01
Manganese	2770	6400 *	5.31E-02	1.75E-01	2.40E-02	CNS	2.21E+00	7.31E+00
						Total CNS	***2.23E+00***	***7.42E+00***
Barium	115	419 *	2.21E-03	1.15E-02	7.00E-02	increased BP	3.15E-02	1.64E-01
Cadmium	0.800	2.0 *	1.53E-05	5.48E-05	5.00E-04	kidney	3.07E-02	1.10E-01
1,2-Dichloroethene(total)	5.20	8.0 *	9.97E-05	2.19E-04	9.00E-03	liver	1.11E-02	2.44E-02
Thallium	3.89	9.0 *	7.46E-05	2.47E-04	8.00E-05	liver	9.33E-01	3.08E+00
						Total liver	9.44E-01	***3.11E+00***
Cyanide	35.6	208 *	6.83E-04	5.70E-03	2.00E-02	CNS	3.41E-02	2.85E-01
Arsenic	68.5	345 *	1.31E-03	9.45E-03	3.00E-04	skin	4.38E+00	3.15E+01
						Total Overall	***7.64E+00***	***4.26E+01***
RSI Landfill - Bedrock								
1,1-Dichloroethene	2.0 *	2.0 *	3.84E-05	5.48E-05	9.00E-03	liver	4.26E-03	6.09E-03
Tetrachloroethene	3.0 *	3.0 *	5.75E-05	8.22E-05	1.00E-02	liver	5.75E-03	8.22E-03
Heptachlor Epoxide	0.00170	0.0020 *	3.26E-08	5.48E-08	1.30E-05	liver	2.51E-03	4.21E-03
						Total liver	1.25E-02	1.85E-02
Arsenic	5.28	11.9 *	1.01E-04	3.26E-04	3.00E-04	skin	3.38E-01	1.09E+00

TABLE 6-43 (continued). HAZARD INDEX FOR THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER, SUMMED BY EFFECT [FUTURE USE SCENARIO]

Chemical	Exposure Point Concentration Central Tendency	Exposure Point Concentration RME	Exposure Case ADD Central Tendency	Exposure Case ADD RME	RfD	Target Organ/ Critical Effect	ADD:RfD Ratio Central Tendency	ADD:RfD Ratio RME
Cyanide	46.5	189 *	8.92E-04	5.16E-03	2.00E-02	CNS	4.46E-02	2.58E-01
Manganese	589	2690 *	1.13E-02	7.37E-02	2.40E-02	CNS	4.71E-01	3.07E+00
						Total CNS	5.15E-01	***3.33E+00***
Silver	6.04	27.4 *	1.16E-04	7.51E-04	5.00E-03	argyria	2.32E-02	1.50E-01
						Total Overall	8.88E-01	***4.58E+00***
B&M Locomotive Shop Disposal Area - Shallow Overburden								
Heptachlor Epoxide	0.00169	0.0030 *	3.24E-08	8.22E-08	1.30E-05	liver	2.49E-03	6.32E-03
Arsenic	3.04	4.30 *	5.83E-05	1.18E-04	3.00E-04	skin	1.94E-01	3.93E-01
Manganese	2295	11,000 *	4.40E-02	3.01E-01	2.40E-02	CNS	1.83E+00	1.26E+01
						Total Overall	***2.03E+00***	***1.30E+01***
B&M Locomotive Shop Disposal Area - Deep Overburden								
Arsenic	5.56	16.6 *	1.07E-04	4.55E-04	3.00E-04	skin	3.55E-01	1.52E+00
Manganese	160	829 *	3.07E-03	2.27E-02	2.40E-02	CNS	1.28E-01	9.46E-01
						Total Overall	4.83E-01	***2.46E+00***
B&M Locomotive Shop Disposal Area - Bedrock								
Arsenic	3.30	5.10 *	6.33E-05	1.40E-04	3.00E-04	skin	2.11E-01	4.66E-01
Manganese	270	519 *	5.18E-03	1.42E-02	2.40E-02	CNS	2.16E-01	5.92E-01
						Total Overall	4.27E-01	***1.06E+00***
Old B&M Oil/Sludge Recycling Area - Shallow Overburden								
Bis(2-ethylhexyl)phthalate	4.83	5.0 *	9.26E-05	1.37E-04	2.00E-02	liver	4.63E-03	6.85E-03
Arsenic	7.43	27.1 *	1.42E-04	7.42E-04	3.00E-04	skin	4.75E-01	2.47E+00
Manganese	541	1,480 *	1.04E-02	4.05E-02	2.40E-02	CNS	4.32E-01	1.69E+00
						Total Overall	9.12E-01	***4.17E+00***
Old B&M Oil/Sludge Recycling Area - Deep Overburden								
Heptachlor Epoxide	0.00151	0.0020 *	2.90E-08	5.48E-08	1.30E-05	liver	2.23E-03	4.21E-03
Arsenic	3.6	7.40 *	6.90E-05	2.03E-04	3.00E-04	skin	2.30E-01	6.76E-01
Manganese	455	1,370 *	8.73E-03	3.75E-02	2.40E-02	CNS	3.64E-01	1.56E+00
						Total Overall	5.96E-01	***2.24E+00***

TABLE 6-43 (continued). HAZARD INDEX FOR THE RESIDENT RECEPTOR FROM THE INGESTION OF GROUNDWATER, SUMMED BY EFFECT [FUTURE USE SCENARIO]

	Exposure Point Concentration		Exposure Case ADD				ADD:RfD Ratio	
Chemical	Central Tendency	RME	Central Tendency	RME	RfD	Target Organ/ Critical Effect	Central Tendency	RME
Old B&M Oil/Sludge Recycling Area - Bedrock								
Chloroform	3.0 *	3.0 *	5.75E-05	8.22E-05	1.00E-02	liver	5.75E-03	8.22E-03
Arsenic	4.23	9.6 *	8.11E-05	2.63E-04	3.00E-04	skin	2.70E-01	8.77E-01
Manganese	334	1370 *	6.41E-03	3.75E-02	2.40E-02	CNS	2.67E-01	1.56E+00
Nickel	14.5	112 *	2.78E-04	3.07E-03	2.00E-02	low body weight	1.39E-02	1.53E-01
						Total Overall	5.57E-01	***2.60E+00***
Asbestos Lagoons - Shallow Overburden								
Arsenic	18.4	58.1 *	3.53E-04	1.59E-03	3.00E-04	skin	1.18E+00	5.31E+00
Manganese	516	1020 *	9.90E-03	2.79E-02	2.40E-02	CNS	4.12E-01	1.16E+00
						Total Overall	***1.59E+00***	***6.47E+00***
Asbestos Lagoons - Deep Overburden								
Bis(2-ethylhexyl)phthalate	5.75	13 *	1.10E-04	3.56E-04	2.00E-02	liver	5.51E-03	1.78E-02
Heptachlor Epoxide	0.00231	0.005 *	4.43E-08	1.37E-07	1.30E-05	liver	3.41E-03	1.05E-02
						Total liver	8.92E-03	2.83E-02
Arsenic	5.67	17.3 *	1.09E-04	4.74E-04	3.00E-04	skin	3.62E-01	1.58E+00
Beryllium	0.634	2.4 *	1.22E-05	6.58E-05	5.00E-03	none observed	2.43E-03	1.32E-02
Manganese	2410	4160 *	4.62E-02	1.14E-01	2.40E-02	CNS	1.93E+00	4.75E+00
						Total Overall	***2.30E+00***	***6.37E+00***
Asbestos Lagoons - Bedrock								
Bis(2-ethylhexyl)phthalate	7.0	17 *	1.34E-04	4.66E-04	2.00E-02	liver	6.71E-03	2.33E-02
Heptachlor Epoxide	0.00225	0.0050 *	4.32E-08	1.37E-07	1.30E-05	liver	3.32E-03	1.05E-02
						Total liver	1.00E-02	3.38E-02
Beryllium	0.700	2.10 *	1.34E-05	5.75E-05	5.00E-03	none observed	2.68E-03	1.15E-02
Cadmium	0.925	2.05 *	1.77E-05	5.62E-05	5.00E-04	kidney	3.55E-02	1.12E-01
Manganese	3200	8745 *	6.14E-02	2.40E-01	2.40E-02	CNS	2.56E+00	9.98E+00
Nickel	38.8	122 *	7.44E-04	3.33E-03	2.00E-02	low body weight	3.72E-02	1.66E-01
						Total Overall	***2.64E+00***	***1.03E+01***

NOTES:
* = Maximum Detected Concentration.

TABLE 6-44. PREDICTED ADULT FEMALE BLOOD LEAD LEVELS FOR WORKERS OF CHILDBEARING AGE

Area of Site	Soil Lead Concentration (1) (µg/g)	Predicted Adult Blood Lead Level (2) (µg/dL)
B&M Railroad Landfill	1020	3.2
B&M Locomotive Shop Disposal Area	2370 (3)	5.1
Contaminated Soil Area	1830	4.3
Metals Hot Spot (4)	10,800 (3)	17
Remainder of Area (5)	380	2.2

NOTES:

1. Exposure point concentration; 95% upper confidence limit on arithmetic average assuming lognormal distribution, unless otherwise noted.
2. The equation for the predicted adult blood lead concentration and default assumptions follow

$$Pb(B)_{adult,central} = Pb(B)_{adult,0} + \frac{Pb(S) * BKSF * IR_s * AF_s * EF_s}{AT}$$

$Pb(B)_{adult,0} = 1.7$ µg/dL
$Pb(S)$ = soil lead concentration (µg/g)
$BKSF = 0.4$ µg/dL per µg/day
$IR_s = 0.05$ g/day
$AF_s = 0.12$
$EF_s = 219$ days/year
$AT = 365$ days/year

3. The maximum detected concentration is used.
4. This area has generally higher lead concentrations and includes 11 samples: SS-22, -23, -24 SS-25, -26, -30, -42, -43, -44, -45, and SS-59.
5. This area consists of the contaminated soil area except the Metals Hot Spot.

TABLE 6-45. OVERALL SUMMARY OF REASONABLE MAXIMUM EXPOSURE CASE RISKS FOR HUMAN HEALTH

Site Media Area of Site	Flow Zone (1)	Principal Contaminants (2)	Risk to Trespasser Hazard Index	Risk to Trespasser Increased Cancer Risk	Risk to Worker Hazard Index	Risk to Worker Increased Cancer Risk	Risk to Resident Hazard Index	Risk to Resident Increased Cancer Risk
Surface Soil								
B&M Railroad Landfill		PAHs, arsenic	0.18	8.5E-06	0.41	3.9E-05		
RSI Landfill		arsenic	0.0059	3.2E-07	0.011	1.5E-06		
B&M Locomotive Shop Disposal Area		arsenic, lead	0.13	4.4E-06	0.24 *(3)*	2.0E-05		
Old B&M Oil/Sludge Recycling Area		arsenic	0.022	7.5E-07	0.041	3.5E-06		
Contaminated Soil Area		arsenic, PAHs, lead	0.075	3.8E-06	0.14 *(3)*	1.8E-05		
Sediment								
West Middlesex Canal Area		arsenic	0.069	3.3E-06				
Central Wetlands Area		arsenic	0.046	2.8E-06				
East Middlesex Canal and Wetlands Area		PAHs, arsenic	0.033	5.2E-06				
Surface Water								
West Middlesex Canal Area		arsenic	0.035	2.4E-07				
Central Wetlands Area		arsenic	0.038	1.2E-07				
East Middlesex Canal and Wetlands Area		arsenic, manganese	0.15	4.5E-06				
Groundwater								
B&M Railroad Landfill	S	arsenic, manganese					***13***	***9.9E-04***
	D	1,1-DCE, manganese					***1.1***	6.3E-05
	B	arsenic, 1,1-DCE, manganese					***3.3***	***4.3E-04***
RSI Landfill	S	arsenic, benzene, manganese					***20***	***3.4E-03***
	D	arsenic, manganese, thallium					***43***	***6.1E-03***
	B	arsenic, manganese					***4.6***	***2.4E-04***
B&M Locomotive Shop Disposal Area	S	arsenic, manganese					***13***	8.6E-05
	D	arsenic					***2.5***	***2.9E-04***
	B	arsenic, manganese					***1.1***	9.0E-05
Old B&M Oil/Sludge Recycling Area	S	arsenic, manganese					***4.2***	***4.8E-04***
	D	arsenic, manganese					***2.2***	***1.3E-04***
	B	arsenic, manganese					***2.6***	***1.7E-04***
Asbestos Lagoon	S	arsenic, manganese					***6.5***	***1.0E-03***
	D	arsenic, beryllium, manganese					***6.4***	***4.3E-04***
	B	beryllium, manganese					***10***	***1.5E-04***

TABLE 6-45 (continued). OVERALL SUMMARY OF REASONABLE MAXIMUM EXPOSURE CASE RISKS FOR HUMAN HEALTH

NOTES:

1. Flow zone abbreviations: S = shallow overburden; D = deep overburden; B = bedrock
2. Principal contaminants are those analytes contributing most to calculated hazard or cancer risk.
   Contaminant abbreviations: 1,1-DCE = 1,1-dichloroethene; PAH = polycyclic aromatic hydrocarbons.
3. A potential excess risk from lead was identified for this area in addition to the estimated hazard index and increased lifetime cancer risk.

Hazard indices exceeding 1 and increased lifetime cancer risks exceeding 1E-04 are highlighted in bold.

TABLE 7-1. WILDLIFE SPECIES OBSERVED AT THE IRON HORSE PARK SUPERFUND SITE DURING THE RECONNAISSANCE SURVEY

Common Name	Scientific Name	East[1]	West[2]	Weston[3]
BIRDS				
American crow	*Corvus brachyrhynchus*	X	X	X
American goldfinch	*Carduelis tristis*	X	X	X
American kestrel	*Falco sparverius*		X	X
American robin	*Turdus migratorius*	X	X	
Belted kingfisher	*Ceryle alcyon*	X		
Black-capped chickadee	*Parus atricapillus*	X	X	X
Blue jay	*Cyanocitta cristata*	X	X	X
Blue-winged warbler	*Vermivora pinus*	X		
Brown-headed cowbird	*Molothrus ater*	X		
Canada goose	*Branta canadensis*	X	X	X
Chimney swift	*Chaetura pelagica*		X	
Chipping sparrow	*Spizella passerina*		X	
Common yellowthroat	*Geothlypis trichas*	X	X	X
Common grackle	*Quiscalus quiscula*	X		X
Downy woodpecker	*Picoides pubescens*	X	X	X
Duck spp.	*Anas* spp.	X		
Eastern kingbird	*Tyrannus tyrannus*	X	X	
Eastern pheobe	*Sayornis phoebe*	X	X	X
Great blue heron	*Andrea herodias*		X	X
Green-backed heron	*Butorides striatus*		X	
Gray catbird	*Dumetella carolinensis*	X	X	X
Hairy woodpecker	*Picoides villosus*	X		X
House finch	*Carpodacus mexicanus*	X	X	
Killdeer	*Charadrius vociferus*	X	X	
Mallard	*Anas platyrhynchos*	X		

TABLE 7-1 (Cont'd). WILDLIFE SPECIES OBSERVED AT THE IRON HORSE PARK SUPERFUND SITE DURING THE RECONNAISSANCE SURVEY

Common Name	Scientific Name	East[1]	West[2]	Weston[3]
Mourning dove	*Zenaida macroura*	X	X	X
Northern mockingbird	*Mimus polyglottus*	X		X
Northern flicker	*Colaptes auratus*	X	X	X
Prairie warbler	*Dendroica discolor*	X		
Red-breasted nuthatch	*Sitta canadensis*	X		
Red-tailed hawk	*Buteo jamaicensis*	X	X	X
Red-winged blackbird	*Agelaius phoeniceus*	X	X	X
Rock dove	*Columba livia*	X	X	
Song sparrow	*Melospiza melodia*	X	X	X
Tree swallow	*Tachycineta bicolor*	X		
Tuffed titmouse	*Parus bicolor*	X		
White-breasted nuthatch	*Sitta carolinensis*	X	X	X
Wood duck	*Aix sponsa*	X		X
Wood thrush	*Hylorichla mustelina*	X	X	
Yellow warbler	*Dendroica petechia*	X		
Yellow-bellied sapsucker	*Sphyrapicus varius*	S		
MAMMALS				
Beaver	*Castor canadensis*	S	S	
Domestic cat	*Felis domesticus*	S		
Eastern chipmunk	*Tamias striatus*	X		
Eastern cottontail	*Sylvilagus floridanus*	X		X
Opossum	*Didelphis virginiana*	S		
Raccoon	*Procyon lotor*	S	S	X
Red fox	*Vulpes vulpes*	X	X	
Shrew spp.	*Sorex*	X		X

TABLE 7-1 (Cont'd). WILDLIFE SPECIES OBSERVED AT THE IRON HORSE PARK SUPERFUND SITE DURING THE RECONNAISSANCE SURVEY

Common Name	Scientific Name	East[1]	West[2]	Weston[3]
Striped skunk	*Mephitis mephitis*	S		
White-tailed deer	*Odocoileus virginianus*	S	S	
Woodchuck	*Marmota monax*	X	S	X
AMPHIBIANS AND REPTILES				
Bullfrog	*Rana catesbeiana*	X	X	
Green frog	*Rana clamitans melanota*	X	X	
Northern leapord frog	*Rana pipeans*	X		
Painted turtle	*Chrysemys p. Picta*	X	X	X
Snapping turtle	*Chelydra s. Serpentina*	X	X	
FISH				
Bluegill	*Lepomis macrochirus*		X	X
Chain pickerel	*Esox niger*		X	X

X = observed visually/aurally; S = observed by sign only.

[1] 10 and 12 May 1993; area east of Pond Street (includes Richardson Pond, Schaffer Landfill, and Content Brook).

[2] 15 July 1993 and 7 October 1994; area west of Pond Street.

[3] Fall 1988 survey by Weston (1989); includes entire survey area.

TABLE 7-2. SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
B&M Railroad Landfill							
Volatile Organics (µg/kg)							
Acetone	5 / 14	14	14.7	10 - 79	7.0 - 42	N	SC
2-Butanone	1 / 14	14	5.54	10 - 12	7.0	N	FD
Methylene Chloride	8 / 14	14	93.6	10 - 53	21 - 280	Y	NAP
Semivolatile Organics (µg/kg)							
Acenaphthene	5 / 14	14	1,660	340 - 11,000	96 - 340	Y	NAP
Acenaphthylene	11 / 14	14	1,670	350 - 11,000	230 - 3,200	Y	NAP
Anthracene	12 / 14	14	1,920	10,000 - 11,000	140 - 5,800	N	SC
Benzo(a)anthracene	14 / 14	14	3,540	NU	260 - 16,000	Y	NAP
Benzo(a)pyrene	14 / 14	14	3,590	NU	200 - 18,000	Y	NAP
Benzo(b)fluoranthene	14 / 14	14	8,210	NU	520 - 33,000	Y	NAP
Benzo(g,h,i)perylene	12 / 14	14	1,940	340 - 10,000	110 - 10,000	Y	NAP
Bis(2-chloroethyl) ether	1 / 14	14	1,670	340 - 11,000	280	N	FD
Bis(2-ethylhexyl)phthalate	7 / 14	14	3,660	350 - 11,000	36 - 25,000	N	SC
Butylbenzylphthalate	5 / 14	14	2,940	340 - 11,000	1,400 - 10,000	Y	NAP
Carbazole	8 / 14	14	1,530	340 - 11,000	90 - 3,400	Y	NAP
Chrysene	14 / 14	14	4,020	NU	380 - 20,000	Y	NAP
Di-n-butylphthalate	1 / 14	14	1,680	340 - 11,000	390	N	FD
Dibenzo(a,h)anthracene	7 / 14	14	1,610	340 - 11,000	90 - 4,200	Y	NAP
Dibenzofuran	5 / 14	14	1,680	340 - 11,000	130 - 290	Y	NAP
Fluoranthene	14 / 14	14	6,050	NU	460 - 28,000	Y	NAP
Fluorene	5 / 14	14	1,670	340 - 11,000	97 - 340	N	SC
Indeno(1,2,3-cd)pyrene	13 / 14	14	2,030	10,000	110 - 10,000	Y	NAP
Isophorone	1 / 14	14	1,680	340 - 11,000	430	N	FD
2-Methylnaphthalene	7 / 14	14	1,670	340 - 11,000	130 - 260	Y	NAP
4-Methylphenol	2 / 14	14	1,650	340 - 11,000	90 - 96	N	FD
Naphthalene	6 / 14	14	1,680	340 - 11,000	100 - 280	N	SC
Phenanthrene	14 / 14	14	2,510	NU	240 - 17,000	Y	NAP
Phenol	3 / 14	14	1,660	340 - 11,000	110 - 200	N	SC
Pyrene	14 / 14	14	6,250	NU	410 - 24,000	Y	NAP
Pesticides and PCBs (µg/kg)							
Aldrin	7 / 14	14	1.57	1.8 - 1.9	0.98 - 3.9	Y	NAP

TABLE 7-2 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
alpha-BHC	5 / 13	13	1.31	1.8 - 2.1	1.1 - 2.5	N	SC
beta-BHC	1 / 14	14	0.950	1.8 - 2.1	1.1	N	SC
delta-BHC	2 / 13	13	0.988	1.8 - 2.1	1.1 - 1.4	N	FD
gamma-BHC(Lindane)	8 / 14	14	0.820	1.8 - 2.1	0.18 - 1.8	N	SC
alpha-Chlordane	6 / 13	13	4.42	1.8 - 2.1	2.7 - 13	N	SC
gamma-Chlordane	5 / 13	13	2.52	1.8 - 2.1	3.4 - 7.5	N	SC
4,4'-DDD	14 / 14	14	28.2	NU	5.9 - 97	N	SC
4,4'-DDE	10 / 14	14	14.3	3.4 - 3.7	5.2 - 50	N	SC
4,4'-DDT	13 / 14	14	62.1	50	11 - 230	Y	NAP
Dieldrin	1 / 13	13	3.09	3.4 - 30	5.2	N	SC
Endosulfan I	2 / 13	13	0.996	1.8 - 2.1	0.85 - 1.9	N	SC
Endosulfan II	5 / 13	13	6.23	3.4 - 4.1	3.4 - 23	N	SC
Endosulfan Sulfate	7 / 13	13	19.9	3.4 - 4.1	5.8 - 79	N	SC
Endrin	11 / 13	13	55.6	3.4	3.0 - 140	Y	NAP
Endrin Aldehyde	7 / 13	13	29.1	3.4 - 4.1	8.3 - 110	Y	NAP
Endrin Ketone	9 / 13	13	55.9	3.4 - 3.7	5.1 - 170	Y	NAP
Heptachlor	3 / 13	13	0.835	1.8 - 2.1	0.46 - 0.59	N	SC
Heptachlor Epoxide	14 / 14	14	3.93	NU	0.69 - 9.7	N	SC
Methoxychlor	10 / 13	13	66.0	18	22 - 170	Y	NAP
Inorganics (mg/kg)							
Aluminum	14 / 14	14	5,420	NU	4,370 - 7,260	N	BKGD
Antimony	1 / 14	14	16.9	7.20 - 25.4	155	Y	NAP
Arsenic	14 / 14	14	18.7	NU	7.50 - 36.0	N	SC
Barium	14 / 14	14	258	NU	26.9 - 922	Y	NAP
Cadmium	8 / 14	14	7.59	0.600 - 1.60	2.10 - 34.8	Y	NAP
Calcium	14 / 14	14	3,290	NU	503 - 14,700	N	EAN
Chromium	13 / 14	14	73.9	11.3	13.7 - 304	Y	NAP
Cobalt	13 / 14	14	9.96	2.90	3.40 - 26.0	N	SC
Copper	14 / 14	14	361	NU	50.4 - 1,030	Y	NAP
Cyanide	10 / 14	14	3.76	0.500 - 0.650	0.630 - 39.0	Y	NAP
Iron	14 / 14	14	35,300	NU	8,985 - 76,800	Y	NAP
Lead	14 / 14	14	559	NU	110 - 1,130	Y	NAP
Magnesium	14 / 14	14	1,930	NU	1,140 - 4,300	N	EAN
Manganese	14 / 14	14	396	NU	135 - 1,080	N	SC

TABLE 7-2 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Mercury	12 / 14	14	1.07	0.100 - 0.110	0.260 - 3.40	Y	NAP
Nickel	9 / 14	14	60.1	10.0 - 12.7	23.5 - 154	N	SC
Potassium	8 / 14	14	463	477 - 592	472 - 792	N	EAN
Selenium	4 / 14	14	0.741	0.600 - 0.70	0.780 - 3.10	N	SC
Silver	1 / 9	9	0.522	0.800 - 1.0	1.20	N	FD
Vanadium	14 / 14	14	17.5	NU	8.70 - 34.8	N	SC
Zinc	14 / 14	14	1,240	NU	53.5 - 4,400	Y	NAP
<u>**RSI Landfill**</u>							
Volatile Organics (μg/kg)							
Methylene Chloride	2 / 6	6	116	10 - 1,200	14 - 64	Y	NAP
Semivolatile Organics (μg/kg)							
Benzo(a)anthracene	1 6	6	162	340	120	N	SC
Benzo(b)fluoranthene	3 / 6	6	205	340	150 - 380	N	SC
Chrysene	2 / 6	6	188	340	110 - 340	N	SC
Fluoranthene	3 / 6	6	190	340	120 - 390	N	SC
Phenol	2 / 6	6	168	340	110 - 220	N	SC
Pyrene	3 / 6	6	188	340	130 - 330	N	SC
Pesticides and PCBs (μg/kg)							
gamma-Chlordane	1 / 6	6	0.805	1.8	0.33	N	SC
4,4'-DDD	5 / 6	6	0.948	3.4	0.25 - 1.6	N	SC
4,4'-DDE	5 / 6	6	1.02	3.4	0.60 - 1.4	N	SC
4,4'-DDT	6 / 6	6	2.53	NU	0.40 - 5.2	N	SC
Endosulfan II	1 / 6	6	1.50	3.4	0.51	N	SC
Endrin	4 / 6	6	1.01	3.4	0.38 - 1.4	Y	NAP
Endrin Ketone	3 / 6	6	1.21	3.4	0.46 - 0.87	Y	NAP
Heptachlor Epoxide	2 / 6	6	0.808	1.8	0.50 - 0.75	N	SC
Methoxychlor	3 / 6	6	5.68	18	0.70 - 4.0	Y	NAP
Inorganics (mg/kg)							
Aluminum	6 / 6	6	7,180	NU	6,120 - 9,470	N	BKGD
Arsenic	6 / 6	6	4.45	NU	3.90 - 4.80	N	BKGD
Barium	6 / 6	6	29.8	NU	15.2 - 46.0	N	SC
Calcium	6 / 6	6	794	NU	313 - 1,180	N	EAN
Chromium	4 / 6	6	13.9	8.60 - 9.50	15.7 - 23.7	Y	NAP
Cobalt	6 / 6	6	3.93	NU	2.18 - 6.50	N	SC

TABLE 7-2 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Copper	5 / 6	6	11.6	6.50	10.7 - 19.7	N	SC
Iron	6 / 6	6	9,710	NU	6,810 - 13,600	Y	NAP
Lead	6 / 6	6	58.8	NU	4.0 - 248	N	SC
Magnesium	6 / 6	6	2,560	NU	1,360 - 3,780	N	EAN
Manganese	6 / 6	6	161	NU	131 - 212	N	SC
Potassium	5 / 6	6	1,370	484	689 - 1,990	N	EAN
Vanadium	6 / 6	6	15.3	NU	9.40 - 20.2	N	SC
Zinc	6 / 6	6	34.2	NU	20.4 - 59.0	N	SC
B&M Locomotive Shop Disposal Area							
Volatile Organics (µg/kg)							
Methylene Chloride	2 / 5	5	9.90	10 - 11	13 - 21	Y	NAP
Semivolatile Organics (µg/kg)							
Acenaphthene	1 / 5	5	304	340 - 400	790	Y	NAP
Acenaphthylene	1 / 5	5	146	340 - 400	20	Y	NAP
Anthracene	2 / 5	5	413	340 - 400	25 - 1,500	N	SC
Benzo(a)anthracene	4 / 5	5	666	340	140 - 2,300	Y	NAP
Benzo(a)pyrene	4 / 5	5	503	340	65 - 1,700	Y	NAP
Benzo(b)fluoranthene	4 / 5	5	890	340	140 - 2,900	N	SC
Benzo(g,h,i)perylene	3 / 5	5	330	340 - 380	130 - 960	N	SC
Benzo(k)fluoranthene	1 / 5	5	164	340 - 400	110	N	SC
Bis(2-ethylhexyl)phthalate	1 / 5	5	166	340 - 400	120	N	SC
Carbazole	1 / 5	5	322	340 - 400	880	N	SC
Chrysene	4 / 5	5	707	340	150 - 2,400	Y	NAP
Dibenzo(a,h)anthracene	1 / 5	5	226	340 - 400	400	N	SC
Dibenzofuran	1 / 5	5	294	340 - 400	740	N	SC
Fluoranthene	5 / 5	5	1,160	NU	140 - 4,200	N	SC
Fluorene	1 / 5	5	298	340 - 400	760	N	SC
Indeno(1,2,3-cd)pyrene	3 / 5	5	314	340 - 380	110 - 920	N	SC
2-Methylnaphthalene	2 / 5	5	224	340 - 380	220 - 370	Y	NAP
Naphthalene	2 / 5	5	200	340 - 380	180 - 290	N	SC
Phenanthrene	5 / 5	5	1,380	NU	100 - 5,900	Y	NAP
Pyrene	5 / 5	5	1,300	NU	170 - 4,800	N	SC
Pesticides and PCBs (µg/kg)							
Aldrin	3 / 5	5	1.43	1.8 - 1.9	0.50 - 2.8	Y	NAP

TABLE 7-2 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
beta-BHC	1 / 5	5	0.942	1.8 - 2.0	0.96	N	SC
alpha-Chlordane	3 / 5	5	0.764	1.8 - 1.9	0.41 - 1.0	N	SC
gamma-Chlordane	3 / 5	5	1.69	1.8 - 1.9	0.62 - 4.0	N	SC
4,4'-DDD	4 / 5	5	2.17	3.8	0.18 - 5.0	N	SC
4,4'-DDE	3 / 5	5	1.72	3.4 - 3.8	1.1 - 2.4	N	SC
4,4'-DDT	4 / 5	5	4.47	3.8	0.48 - 9.3	N	SC
Dieldrin	1 / 5	5	1.74	3.4 - 3.8	1.7	N	SC
Endosulfan II	3 / 5	5	1.59	3.4 - 3.8	1.2 - 2.0	N	SC
Endrin	5 / 5	5	1.82	NU	0.20 - 3.5	Y	NAP
Endrin Ketone	1 / 5	5	2.57	3.4 - 3.9	5.6	Y	NAP
Heptachlor Epoxide	3 / 5	5	1.15	1.8 - 1.9	0.69 - 1.8	N	SC
Methoxychlor	2 / 5	5	9.48	18 - 19	0.89 - 19	Y	NAP
Aroclor-1016	1 / 5	5	14.5	34 - 39	2.2	N	FD
Inorganics (mg/kg)							
Aluminum	5 / 5	5	5,330	NU	4,350 - 7,660	N	BKGD
Antimony	2 / 5	5	14.2	9.30	4.10 - 53.0	Y	NAP
Arsenic	5 / 5	5	17.3	NU	4.50 - 49.3	N	SC
Barium	5 / 5	5	99.1	NU	22.2 - 342	N	SC
Beryllium	1 / 5	5	0.442	0.320 - 0.800	0.850	N	FD
Cadmium	1 / 5	5	0.540	0.400 - 1.0	1.0	N	SC
Calcium	5 / 5	5	2,200	NU	570 - 6,090	N	EAN
Chromium	4 / 5	5	31.1	11.6	20.4 - 87.4	Y	NAP
Cobalt	4 / 5	5	5.93	2.30	3.90 - 13.9	N	SC
Copper	5 / 5	5	734	NU	12.7 - 3,135	Y	NAP
Cyanide	2 / 5	5	0.515	0.500	0.890 - 0.935	N	SC
Iron	5 / 5	5	34,800	NU	7,020 - 101,350	Y	NAP
Lead	4 / 5	5	575	5.20	13.2 - 2,370	Y	NAP
Magnesium	5 / 5	5	2,550	NU	1,370 - 4,225	N	EAN
Manganese	5 / 5	5	322	NU	99.4 - 917	N	SC
Mercury	1 / 5	5	0.103	0.0500 - 0.200	0.190	Y	NAP
Nickel	3 / 5	5	18.2	8.80 - 13.3	14.3 - 46.5	N	SC
Potassium	3 / 5	5	658	472 - 474	423.8 - 1,660	N	EAN
Selenium	2 / 5	5	1.46	0.600 - 0.650	0.880 - 5.50	N	SC
Sodium	1 / 5	5	2,640	62.9 - 143	13,000	N	EAN

TABLE 7-2 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Thallium	1 / 5	5	0.362	0.600 - 0.680	0.570	N	FD
Vanadium	5 / 5	5	12.5	NU	7.60 - 17.9	N	SC
Zinc	5 / 5	5	222	NU	28.1 - 821	Y	NAP
Old B&M Oil/Sludge Recycling Area							
Volatile Organics (μg/kg)							
Carbon Disulfide	1 / 6	6	4.58	10 - 11	2.0	N	3
Semivolatile Organics (μg/kg)							
Anthracene	1 / 6	6	173	330 - 680	19	N	3
Benzo(a)anthracene	3 / 6	6	155	330 - 680	39 - 140	N	3
Benzo(a)pyrene	3 / 6	6	146	330 - 680	51 - 80	N	3
Benzo(b)fluoranthene	3 / 6	6	168	330 - 680	61 - 200	N	3
Benzo(g,h,i)perylene	1 / 6	6	183	330 - 680	80	N	3
Benzo(k)fluoranthene	3 / 6	6	145	330 - 680	39 - 110	N	3
Carbazole	1 / 6	6	176	330 - 680	33	N	3
Chrysene	3 / 6	6	179	330 - 680	79 - 200	N	3
Dibenzofuran	1 / 6	6	174	330 - 680	22	N	3
Fluoranthene	3 / 6	6	211	330 - 680	71 - 400	N	3
Indeno(1,2,3-cd)pyrene	1 / 6	6	180	330 - 680	55	N	3
2-Methylnaphthalene	1 / 6	6	183	330 - 680	77	N	3
Naphthalene	1 / 6	6	177	330 - 680	43	N	3
Phenanthrene	2 / 6	6	195	330 - 680	140 - 180	N	3
Pyrene	3 / 6	6	199	330 - 680	56 - 300	N	3
Pesticides and PCBs (μg/kg)							
alpha-Chlordane	1 / 6	6	1.61	1.7 - 1.8	5.2	N	3
gamma-Chlordane	1 / 6	6	1.59	1.7 - 1.8	5.1	N	3
4,4'-DDD	1 / 6	6	4.09	3.3 - 3.5	16	N	3
4,4'-DDE	1 / 6	6	3.43	3.3 - 3.5	12	N	3
4,4'-DDT	1 / 6	6	2.23	3.3 - 6.8	3.1	N	3
Endosulfan I	1 / 6	6	2.14	1.7 - 1.8	8.4	N	3
Endosulfan II	1 / 6	6	2.68	3.3 - 3.5	7.5	N	3
Endrin	2 / 6	6	3.11	3.3 - 3.5	2.0 - 9.8	N	3
Endrin Ketone	2 / 6	6	2.59	3.3 - 3.5	2.8 - 5.9	N	3
Inorganics (mg/kg)							
Aluminum	6 / 6	6	6,300	NU	4,130 - 8,640	N	3

TABLE 7-2 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Antimony	1 / 6	6	3.64	3.0 - 3.30	14.1	N	3
Arsenic	6 / 6	6	8.80	NU	6.60 - 10.8	N	3
Barium	6 / 6	6	25.0	NU	14.1 - 38.7	N	3
Beryllium	1 / 6	6	0.128	0.200	0.270	N	3
Calcium	6 / 6	6	995	NU	616 - 1,530	N	3
Chromium	4 / 6	6	13.6	12.7 - 13.2	15.6 - 18.1	N	3
Cobalt	5 / 6	6	3.74	2.90	3.30 - 4.80	N	3
Copper	6 / 6	6	18.0	NU	7.0 - 41.1	N	3
Iron	6 / 6	6	9,320	NU	7,550 - 10,600	N	3
Lead	6 / 6	6	82.6	NU	10.8 - 362	N	3
Magnesium	6 / 6	6	2,410	NU	1,950 - 2,940	N	3
Manganese	6 / 6	6	110	NU	88.1 - 135	N	3
Potassium	6 / 6	6	933	NU	678 - 1,190	N	3
Selenium	1 / 6	6	0.274	0.440 - 0.480	0.500	N	3
Vanadium	6 / 6	6	15.4	NU	11.7 - 18.7	N	3
Zinc	6 / 6	6	51.0	NU	23.7 - 133	N	3
<u>**Contaminated Soil Area**</u>							
Volatile Organics (µg/kg)							
Acetone	10 / 46	46	18.0	11 - 120	6.0 - 62	N	3
Chloroethane	4 / 46	46	9.78	10 - 12	23 - 79	N	3
Methylene Chloride	34 / 46	46	79.3	11 - 62	6.0 - 450	N	3
Semivolatile Organics (µg/kg)							
Acenaphthene	3 / 45	45	1,410	340 - 11,000	100 - 8,000	N	3
Acenaphthylene	21 / 46	46	1,370	350 - 12,000	78 - 540	N	3
Anthracene	25 / 46	46	1,350	350 - 11,000	130 - 12,000	N	3
Benzo(a)anthracene	32 / 45	45	1,700	350 - 11,000	140 - 18,000	N	3
Benzo(a)pyrene	32 / 45	45	1,640	350 - 11,000	110 - 15,000	N	3
Benzo(b)fluoranthene	39 / 45	45	2,560	350 - 11,000	130 - 28,000	N	3
Benzo(g,h,i)perylene	25 / 45	45	1,450	340 - 11,000	100 - 7,400	N	3
Chrysene	36 / 45	45	1,780	350 - 11,000	120 - 20,000	N	3
Di-n-butylphthalate	1 / 45	45	1,530	340 - 12,000	7,600	N	3
Dibenzo(a,h)anthracene	11 / 45	45	1,300	340 - 11,000	94 - 3,300	N	3
Dibenzofuran	17 / 46	46	1,420	350 - 11,000	56 - 10,000	N	3
2,4-Dimethylphenol	1 / 45	45	1360	340 - 12000	130	N	3

TABLE 7-2 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Bis(2-ethylhexyl)phthalate	13 / 44	44	1,410	350 - 12,000	120 - 4,200	N	3
Fluoranthene	42 / 46	46	2,520	350 - 11,000	140 - 40,000	N	3
Fluorene	5 / 46	46	1,380	340 - 11,000	95 - 8,100	N	3
Indeno(1,2,3-cd)pyrene	30 / 45	45	1,360	350 - 11,000	87 - 7,900	N	3
2-Methylnaphthalene	32 / 46	46	1,270	350 - 11,000	98 - 5,200	N	3
2-Methylphenol	1 / 45	45	1,360	340 - 12,000	150	N	3
4-Methylphenol	1 / 45	45	1,370	340 - 12,000	280	N	3
Naphthalene	28 / 46	46	1,300	350 - 11,000	97 - 8,500	N	3
Pentachlorophenol	9 / 46	46	4,480	830 - 30,000	140 - 75,000	N	3
Phenanthrene	39 / 46	46	2,250	350 - 11,000	99 - 48,000	N	3
Phenol	2 / 45	45	1,370	340 - 12,000	220 - 230	N	3
Pyrene	42 / 45	45	2,320	350 - 11,000	110 - 32,000	N	3
Carbazole	15 / 46	46	1,400	350 - 11,000	87 - 8,900	N	3
Pesticides and PCBs (μg/kg)							
Aldrin	42 / 46	46	2.22	1.8 - 1.9	0.23 - 8.1	N	3
alpha-BHC	17 / 44	44	0.931	1.8 - 2.0	0.37 - 1.8	N	3
beta-BHC	6 / 43	43	0.963	1.8 - 2.0	0.34 - 2.4	N	3
gamma-BHC(Lindane)	11 / 44	44	0.986	1.8 - 2.0	0.21 - 5.3	N	3
alpha-Chlordane	17 / 44	44	1.20	1.8 - 2.0	0.49 - 8.3	N	3
gamma-Chlordane	35 / 46	46	3.12	1.8 - 2.0	0.41 - 11	N	3
4,4'-DDD	46 / 46	46	14.3	NU	1.1 - 150	N	3
4,4'-DDE	41 / 45	45	8.08	3.5 - 3.9	1.7 - 22	N	3
4,4'-DDT	44 / 46	46	372	3.5 - 3.6	4.4 - 16,000	N	3
Dieldrin	10 / 43	43	2.86	3.5 - 3.9	2.5 - 17	N	3
Endosulfan I	4 / 43	43	1.95	1.8 - 2.0	3.7 - 32	N	3
Endosulfan II	20 / 43	43	1.89	3.5 - 3.9	0.40 - 4.2	N	3
Endosulfan Sulfate	20 / 44	44	7.29	3.4 - 3.9	2.2 - 75	N	3
Endrin	30 / 44	44	4.02	3.4 - 3.9	0.38 - 12	N	3
Endrin Aldehyde	12 / 43	43	2.67	3.4 - 3.9	2.5 - 15	N	3
Endrin Ketone	31 / 44	44	7.90	3.5 - 3.9	0.86 - 63	N	3
Heptachlor	3 / 43	43	0.893	1.8 - 2.0	0.24 - 0.54	N	3
Heptachlor Epoxide	21 / 44	44	1.36	1.8 - 2.0	0.74 - 7.8	N	3
Methoxychlor	17 / 45	45	18.9	18 - 20	11 - 76	N	3

TABLE 7-2 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Inorganics (mg/kg)							
Antimony	15 / 46	46	28.2	7.60 - 33.7	7.98 - 494	N	3
Arsenic	46 / 46	46	25.8	NU	5.80 - 233	N	3
Barium	46 / 46	46	226	NU	19.6 - 3,630	N	3
Cadmium	9 / 46	46	1.17	0.600 - 2.20	1.10 - 8.0	N	3
Calcium	44 / 46	46	2,120	287 - 379	510 - 9,730	N	3
Chromium	44 / 46	46	42.8	12.4 - 12.6	13.3 - 385	N	3
Cobalt	45 / 46	46	6.93	2.50	3.20 - 15.2	N	3
Copper	45 / 46	46	1,510	89.2	35.6 - 46,200	N	3
Cyanide	6 / 46	46	0.332	0.500 - 0.620	0.570 - 0.810	N	3
Iron	46 / 46	46	37,400	NU	11,800 - 146,000	N	3
Lead	46 / 46	46	1,310	NU	69.1 - 10,800	N	3
Magnesium	46 / 46	46	2,560	NU	682 - 6,630	N	3
Manganese	46 / 46	46	425	NU	105 - 3,400	N	3
Mercury	28 / 46	46	0.432	0.110 - 0.220	0.120 - 2.50	N	3
Nickel	34 / 46	46	32.4	7.50 - 14.0	12.4 - 329	N	3
Potassium	19 / 46	46	616	487 - 3,830	309 - 2,460	N	3
Selenium	17 / 46	46	0.720	0.600 - 1.40	0.700 - 3.90	N	3
Silver	1 / 35	35	0.755	0.860 - 0.990	11.1	N	3
Vanadium	46 / 46	46	16.8	NU	6.60 - 48.8	N	3
Zinc	46 / 46	46	443	NU	29.4 - 4,170	N	3

NOTES:

1. The number of samples in which the contaminant was detected divided by the total number of samples analyzed.
2. The number of samples used in calculating the mean. This number may differ from the denominator of the frequency of detection, because non-detect samples with high detection limits were not included in calculating the mean.
3. Due to limited habitat quality, the old B&M Oil/Sludge Recycling Area and the Contaminated Soil Area were not qualitatively evaluated. As a result , no COPC were selected for these 2 groups.

NU = Not used; chemical was detected in all samples or non-detect samples were excluded from the data set due to high detection limits (one-half the detection was greater than the maximum detected concentration across all samples in the grouping).

NAP = Not applicable.

BKGD = Background comparison. See Table 7-8.

FD = Frequency of detection. See Table 7-5.

SC = Screening criterion. See Table 7-8.

EAN = Essential animal nutrient.

TABLE 7-3. SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
West Middlesex Canal Group							
Volatile Organics (µg/kg)							
2-Butanone	1 / 13	13	10.7	13 - 30	22	Y	NAP
Toluene	1 / 13	13	10.2	13 - 30	18	N	SC
Xylenes (total)	1 / 13	13	18.2	13 - 30	120	N	SC
Semivolatile Organics (µg/kg)							
Benzo(a)anthracene	4 / 13	13	4,080	450 - 26,000	66 - 2,600	Y	NAP
Benzo(a)pyrene	1 / 13	13	4,890	450 - 26,000	70	N	SC
Benzo(b)fluoranthene	6 / 14	14	3,870	460 - 26,000	35 - 3,600	Y	NAP
Benzo(k)fluoranthene	1 / 13	13	4,170	450 - 26,000	3,000	Y	NAP
Bis(2-ethylhexyl)phthalate	6 / 13	13	4,120	620 - 26,000	62 - 7,400	N	SC
Butylbenzylphthalate	1 / 14	14	4,580	450 - 26,000	350	Y	NAP
Chrysene	7 / 15	15	3,610	460 - 26,000	23 - 3,600	Y	NAP
Fluoranthene	8 / 15	15	3,740	460 - 26,000	41 - 5,400	Y	NAP
2-Methylnaphthalene	1 / 13	13	4,020	450 - 25,000	1,500	Y	NAP
Phenanthrene	6 / 14	14	3,740	460 - 26,000	25 - 2,000	Y	NAP
Pyrene	8 / 15	15	4,230	460 - 26,000	47 - 620	Y	NAP
Pesticides and PCBs (µg/kg)							
alpha-BHC	2 / 13	13	1.47	2.3 - 5.1	0.40 - 0.46	N	SC
delta-BHC	1 / 13	13	1.58	2.3 - 5.1	0.32	N	SC
alpha-Chlordane	3 / 14	14	3.61	2.3 - 5.1	1.2 - 18	Y	NAP
gamma-Chlordane	2 / 13	13	2.91	2.3 - 5.1	1.4 - 18	Y	NAP
4,4'-DDD	7 / 14	14	7.15	4.5 - 8.5	0.64 - 34	Y	NAP
4,4'-DDE	8 / 13	13	4.14	4.5 - 8.5	0.090 - 18	Y	NAP
Dieldrin	7 / 13	13	2.61	4.5 - 8.5	0.14 - 10	Y	NAP
Endosulfan I	5 / 13	13	1.31	2.3 - 5.1	0.21 - 2.0	Y	NAP
Endosulfan II	3 / 13	13	2.81	4.5 - 10	0.72 - 2.0	Y	NAP
Endrin	5 / 13	13	2.84	3.8 - 8.3	0.26 - 5.3	Y	NAP
Heptachlor Epoxide	3 / 13	13	1.75	2.3 - 5.1	1.0 - 3.1	N	SC
Methoxychlor	4 / 13	13	12.9	23 - 51	3.3 - 7.6	Y	NAP
Aroclor-1016	1 / 13	13	31.1	45 - 100	4.4	N	FD
Aroclor-1242	1 / 13	13	30.0	45 - 85	13	N	SC
Aroclor-1248	7 / 15	15	258	45 - 100	19 - 2,000	Y	NAP
Aroclor-1254	1 / 13	13	32.6	45 - 100	24	N	SC

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Inorganics (mg/kg)							
Aluminum	15 / 15	15	8,150	NU	2,520 - 29,400	Y	NAP
Arsenic	13 / 15	15	16.4	3.90 - 6.0	1.55 - 101	Y	NAP
Barium	15 / 15	15	46.0	NU	14.1 - 111	Y	NAP
Beryllium	2 / 15	15	0.567	0.0500 - 0.940	1.90 - 3.80	Y	NAP
Cadmium	3 / 13	13	0.771	0.200 - 0.760	0.710 - 5.40	Y	NAP
Calcium	14 / 15	15	55,500	491	643 - 215,000	N	EAN
Chromium	7 / 15	15	25.4	9.20 - 13.5	12.0 - 100	Y	NAP
Cobalt	9 / 15	15	8.39	2.30 - 8.90	3.40 - 48.6	Y	NAP
Copper	12 / 15	15	36.6	6.40 - 20.4	8.10 - 215	Y	NAP
Iron	15 / 15	15	10,500	NU	3,860 - 33,550	Y	NAP
Lead	14 / 15	15	86.9	10.5	10.6 - 554	Y	NAP
Magnesium	15 / 15	15	2,500	NU	915 - 5,440	N	EAN
Manganese	15 / 15	15	437	NU	54.4 - 2,745	Y	NAP
Mercury	3 / 13	13	0.103	0.0600 - 0.120	0.110 - 0.480	Y	NAP
Nickel	4 / 15	15	18.0	4.10 - 15.8	19.0 - 132	Y	NAP
Potassium	13 / 15	15	748	361 - 368	495 - 1,780	N	EAN
Selenium	5 / 15	15	1.55	0.670 - 5.60	0.810 - 7.20	Y	NAP
Sodium	1 / 14	14	234	114 - 514	1,670	N	EAN
Vanadium	15 / 15	15	24.1	NU	7.30 - 110	Y	NAP
Zinc	13 / 15	15	105	11.7 - 20.2	39.4 - 504	Y	NAP
Wetland 2 Group							
Volatile Organics (μg/kg)							
Acetone	3 / 26	26	52.8	13 - 1,100	15 - 52	N	SC
2-Butanone	6 / 27	27	31.9	13 - 120	16 - 300	Y	NAP
Chlorobenzene	1 / 27	27	16.2	13 - 120	9.0	N	SC
Semivolatile Organics (μg/kg)							
Acenaphthene	15 / 28	28	924	420 - 18,000	28 - 2,600	Y	NAP
Acenaphthylene	3 / 27	27	952	390 - 18,000	53 - 2,200	Y	NAP
Anthracene	15 / 28	28	986	420 - 18,000	37 - 5,200	Y	NAP
Benzo(a)anthracene	16 / 28	28	2,440	420 - 18,000	150 - 40,000	Y	NAP
Benzo(a)pyrene	16 / 28	28	1,530	420 - 18,000	73 - 18,000	Y	NAP
Benzo(b)fluoranthene	17 / 29	29	3,100	420 - 18,000	150 - 60,000	Y	NAP
Benzo(g,h,i)perylene	9 / 27	27	1,470	420 - 31,000	44 - 740	Y	NAP

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Benzo(k)fluoranthene	15 / 28	28	1,520	420 - 31,000	82 - 2,500	Y	NAP
Bis(2-ethylhexyl)phthalate	11 / 27	27	1,670	390 - 18,000	62 - 17,000	N	SC
Butylbenzylphthalate	4 / 28	28	1,470	390 - 31,000	41 - 1,800	Y	NAP
Carbazole	7 / 27	27	929	420 - 18,000	31 - 2,300	Y	NAP
bis(2-Chloroethyl) ether	1 / 27	27	1,490	390 - 31,000	550	N	FD
Chrysene	21 / 29	29	1,810	420 - 18,000	19 - 25,000	Y	NAP
Dibenzo(a,h)anthracene	3 / 27	27	1,480	420 - 31,000	84 - 140	Y	NAP
Dibenzofuran	12 / 28	28	864	420 - 18,000	35 - 1,600	N	SC
1,2-Dichlorobenzene	1 / 27	27	1,500	390 - 31,000	750	N	FD
1,4-Dichlorobenzene	1 / 27	27	1,480	390 - 31,000	230	N	FD
Fluoranthene	26 / 29	29	2,860	420 - 12,000	36 - 48,000	Y	NAP
Fluorene	16 / 28	28	684	420 - 12,000	51 - 3,300	Y	NAP
Indeno(1,2,3-cd)pyrene	11 / 27	27	1,560	420 - 18,000	54 - 18,000	Y	NAP
2-Methylnaphthalene	11 / 27	27	901	420 - 18,000	21 - 1,500	Y	NAP
4-Methylphenol	6 / 27	27	952	390 - 18,000	76 - 2,900	Y	NAP
Naphthalene	14 / 27	27	896	420 - 18,000	31 - 2,300	Y	NAP
N-Nitrosodiphenylamine	4 / 27	27	1,450	390 - 31,000	100 - 300	Y	NAP
Phenanthrene	24 / 28	28	2,180	420 - 12,000	19 - 36,000	Y	NAP
Pyrene	26 / 29	29	3,290	420 - 12,000	44 - 62,000	Y	NAP
Pesticides and PCBs (µg/kg)							
Aldrin	2 / 27	27	1.96	2.0 - 19	0.080 - 0.16	N	SC
alpha-BHC	1 / 27	27	2.0	2.0 - 19	0.25	N	SC
beta-BHC	1 / 27	27	2.0	2.0 - 19	0.19	N	SC
delta-BHC	2 / 27	27	1.83	2.0 - 19	0.62 - 3.3	Y	NAP
gamma-BHC(Lindane)	2 / 27	27	2.05	2.0 - 19	0.23 - 8.3	N	FD
alpha-Chlordane	4 / 27	27	1.63	2.0 - 14	0.17 - 3.4	N	SC
gamma-Chlordane	4 / 27	27	1.61	2.0 - 14	0.40 - 1.7	N	SC
4,4'-DDD	13 / 27	27	9.23	3.9 - 13	0.23 - 83	Y	NAP
4,4'-DDE	15 / 27	27	5.42	3.9 - 7.1	0.29 - 47	Y	NAP
Dieldrin	10 / 27	27	4.37	3.9 - 37	0.14 - 17	Y	NAP
Endosulfan II	6 / 27	27	2.76	3.9 - 13	0.24 - 8.0	Y	NAP
Endosulfan Sulfate	1 / 27	27	3.55	3.9 - 37	1.5	Y	NAP
Endrin	8 / 27	27	4.11	3.9 - 37	0.16 - 15	Y	NAP
Endrin Aldehyde	3 / 27	27	11.2	3.9 - 37	8.2 - 190	Y	NAP

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Endrin Ketone	1 / 27	27	3.91	3.9 - 37	3.7	Y	NAP
Heptachlor Epoxide	5 / 27	27	1.48	2.0 - 14	0.12 - 0.93	N	SC
Methoxychlor	1 / 27	27	17.9	20 - 140	26	Y	NAP
Aroclor-1232	1 / 27	27	39.5	39 - 370	3.8	N	SC
Aroclor-1242	3 / 27	27	33.7	39 - 280	6.8 - 43	N	SC
Aroclor-1248	9 / 27	27	52.4	39 - 370	9.1 - 570	Y	NAP
Aroclor-1254	1 / 27	27	49.8	39 - 370	320	Y	NAP
Inorganics (mg/kg)							
Aluminum	29 / 29	29	6,950	NU	3,050 - 30,200	Y	NAP
Antimony	8 / 26	26	12.0	2.30 - 34.1	3.18 - 158	Y	NAP
Arsenic	29 / 29	29	14.9	NU	2.60 - 40.8	Y	NAP
Barium	29 / 29	29	61.7	NU	11.9 - 197	Y	NAP
Beryllium	7 / 27	27	0.620	0.100 - 1.70	0.510 - 3.70	Y	NAP
Cadmium	2 / 25	25	0.460	0.300 - 2.60	1.20 - 3.40	Y	NAP
Calcium	26 / 29	29	3,020	629 - 800	518 - 11,100	N	EAN
Chromium	13 / 29	29	20.6	5.30 - 16.8	13.8 - 106	Y	NAP
Cobalt	20 / 29	29	7.89	2.90 - 5.30	3.20 - 24.7	Y	NAP
Copper	21 / 29	29	259	6.10 - 25.6	6.60 - 3,600	Y	NAP
Cyanide	1 / 24	24	0.540	0.600 - 4.40	1.20	N	FD
Iron	29 / 29	29	13,600	NU	4,680 - 50,200	Y	NAP
Lead	29 / 29	29	302	NU	5.70 - 2,970	Y	NAP
Magnesium	29 / 29	29	2,050	NU	936 - 7,400	N	EAN
Manganese	29 / 29	29	322	NU	49.0 - 1,230	Y	NAP
Mercury	15 / 29	29	0.159	0.0500 - 0.0900	0.0700 - 0.950	Y	NAP
Nickel	7 / 29	29	11.6	5.40 - 41.2	14.6 - 45.3	Y	NAP
Potassium	28 / 29	29	864	366	277 - 4,630	N	EAN
Selenium	17 / 28	28	2.05	0.570 - 2.80	0.605 - 10.2	Y	NAP
Silver	2 / 25	25	0.901	0.900 - 6.0	0.830 - 2.90	Y	NAP
Sodium	1 / 27	27	232	81.0 - 1,170	1,700	N	EAN
Vanadium	29 / 29	29	15.9	NU	5.70 - 52.5	Y	NAP
Zinc	28 / 29	29	167	19.5	23.2 - 998	Y	NAP
East Middlesex Canal Group							
Volatile Organics (µg/kg)							
Acetone	6 / 11	11	30.7	13 - 26	8.0 - 120	Y	NAP

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Bromomethane	1 / 11	11	15.5	13 - 67	44	N	FD
2-Butanone	2 / 11	11	13.2	13 - 26	31 - 35	Y	NAP
Chloromethane	1 / 11	11	12.7	13 - 67	14	N	FD
Toluene	4 / 11	11	24.4	13 - 42	24 - 110	N	SC
1,1,1-Trichloroethane	1 / 12	12	12.0	13 - 67	10	N	FD
Xylenes (total)	1 / 11	11	12.3	13 - 67	9.0	N	SC
Semivolatile Organics (µg/kg)							
Benzo(a)anthracene	1 / 11	11	5,180	410 - 67,000	94	N	SC
Benzo(a)pyrene	3 / 11	11	5,140	410 - 67,000	36 - 62	N	SC
Benzo(b)fluoranthene	3 / 11	11	5,140	410 - 67,000	42 - 120	N	SC
Benzo(k)fluoranthene	1 / 11	11	5,180	410 - 67,000	73	N	SC
Bis(2-ethylhexyl)phthalate	2 / 11	11	5,160	410 - 67,000	67 - 68	N	SC
Chrysene	3 / 11	11	5,140	410 - 67,000	27 - 120	N	SC
Fluoranthene	4 / 11	11	5,130	410 - 67,000	49 - 260	N	SC
4-Methylphenol	1 / 11	11	5,180	410 - 67,000	50	N	SC
Naphthalene	1 / 11	11	5,180	410 - 67,000	68	N	SC
Phenanthrene	2 / 11	11	5,150	410 - 67,000	26 - 35	N	SC
Pyrene	5 / 11	11	5,110	410 - 67,000	41 - 370	N	SC
Pesticides and PCBs (µg/kg)							
beta-BHC	1 / 11	11	1.62	2.1 - 7.1	0.33	N	SC
delta-BHC	2 / 11	11	1.52	2.1 - 7.1	0.13 - 0.39	N	SC
alpha-Chlordane	2 / 11	11	1.40	2.1 - 4.3	0.21 - 1.3	N	SC
gamma-Chlordane	3 / 11	11	1.36	2.1 - 7.1	0.14 - 0.41	N	SC
4,4'-DDD	7 / 11	11	4.78	4.1 - 7.0	0.26 - 21	Y	NAP
4,4'-DDE	6 / 11	11	2.72	4.1 - 8.4	0.64 - 7.2	Y	NAP
4,4'-DDT	2 / 11	11	3.22	4.1 - 22	0.28 - 0.31	N	SC
Dieldrin	3 / 11	11	2.64	4.1 - 14	0.30 - 1.0	N	SC
Endosulfan I	2 / 11	11	1.60	2.1 - 7.1	0.24 - 1.2	Y	NAP
Endosulfan Sulfate	1 / 11	11	3.13	4.1 - 14	0.44	Y	NAP
Endrin	1 / 11	11	3.86	4.1 - 22	0.16	N	SC
Methoxychlor	2 / 11	11	17.9	21 - 110	0.22 - 0.42	Y	NAP
Aroclor-1232	1 / 11	11	44.5	41 - 140	150	N	SC
Aroclor-1242	1 / 11	11	40.3	41 - 220	19	N	SC

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Inorganics (mg/kg)							
Aluminum	12 / 12	12	3,080	NU	1,260 - 5,190	N	BKGD
Arsenic	8 / 10	10	4.93	2.0 - 3.0	2.70 - 10.1	Y	NAP
Barium	12 / 12	12	44.9	NU	11.4 - 100	Y	NAP
Beryllium	1 / 11	11	0.269	0.0500 - 0.500	1.70	N	BKGD
Calcium	11 / 12	12	2,300	388	678 - 10,300	N	EAN
Cobalt	6 / 10	10	4.56	2.10 - 6.20	3.70 - 10.0	Y	NAP
Copper	7 / 12	12	8.25	4.20 - 26.0	8.90 - 17.7	N	BKGD
Iron	12 / 12	12	4,790	NU	1,670 - 8,810	N	SC
Lead	11 / 12	12	50.3	5.30	3.60 - 310	Y	NAP
Magnesium	12 / 12	12	1,030	NU	414 - 1,620	N	EAN
Manganese	12 / 12	12	549	NU	26.1 - 2,700	Y	NAP
Mercury	4 / 11	11	0.126	0.0600 - 0.100	0.120 - 0.650	Y	NAP
Potassium	7 / 10	10	353	185 - 345	363 - 646	N	EAN
Selenium	1 / 10	10	0.77	0.700 - 2.0	2.10	Y	NAP
Vanadium	12 / 12	12	8.07	NU	2.70 - 15.9	Y	NAP
Zinc	9 / 12	12	31.7	14.2 - 15.6	26.5 - 60.1	N	SC
Richardson Pond Group							
Volatile Organics (µg/kg)							
Acetone	8 / 12	12	109	16 - 79	27 - 503	Y	NAP
Benzene	2 / 12	12	21.0	16 - 100	3.0 - 54	Y	NAP
2-Butanone	9 / 16	16	52.9	16 - 91	15 - 210	Y	NAP
1,2-Dichloroethene(total)	1 / 12	12	24.4	16 - 100	70	Y	NAP
1,1,2,2-Tetrachloroethane	1 / 12	12	24.0	16 - 100	80	N	FD
Toluene	5 / 12	12	45.6	16 - 100	4.0 - 200	N	SC
Xylenes (total)	2 / 12	12	103	16 - 100	49 - 990	Y	NAP
Semivolatile Organics (µg/kg)							
Acenaphthene	2 / 13	13	4,830	460 - 91,000	4,600 - 6,550	Y	NAP
Anthracene	3 / 13	13	4,760	460 - 91,000	25 - 6,350	Y	NAP
Benzo(a)anthracene	8 / 13	13	6,800	550 - 91,000	38 - 21,000	Y	NAP
Benzo(a)pyrene	7 / 14	14	5,510	550 - 91,000	61 - 15,000	Y	NAP
Benzo(b)fluoranthene	9 / 13	13	6,050	550 - 91,000	75 - 19,000	Y	NAP
Benzo(g,h,i)perylene	3 / 13	13	5,140	520 - 91,000	190 - 8,950	Y	NAP
Benzo(k)fluoranthene	3 / 13	13	5,700	520 - 91,000	120 - 12,500	Y	NAP

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Bis(2-ethylhexyl)phthalate	1 / 13	13	4,690	460 - 91,000	2,800	N	SC
Butylbenzylphthalate	1 / 14	14	4,900	460 - 91,000	910	Y	NAP
Chrysene	8 / 13	13	6,200	550 - 91,000	36 - 20,000	Y	NAP
Dibenzo(a,h)anthracene	3 / 13	13	4,300	520 - 91,000	100 - 2,950	Y	NAP
Dibenzofuran	4 / 13	13	4,130	550 - 91,000	61 - 1,300	N	SC
Fluoranthene	9 / 13	13	8,120	550 - 91,000	62 - 32,500	Y	NAP
Fluorene	4 / 13	13	4,740	550 - 91,000	39 - 6,600	Y	NAP
Indeno(1,2,3-cd)pyrene	4 / 13	13	4,890	550 - 91,000	38 - 7,700	Y	NAP
2-Methylnaphthalene	4 / 13	13	5,090	550 - 91,000	93 - 190	Y	NAP
4-Methylphenol	6 / 14	14	4,780	460 - 91,000	51 - 720	Y	NAP
Naphthalene	6 / 13	13	5,040	550 - 91,000	58 - 650	Y	NAP
Phenanthrene	9 / 13	13	8,060	550 - 91,000	68 - 31,500	Y	NAP
Pyrene	9 / 13	13	11,100	860 - 91,000	59 - 48,000	Y	NAP
Pesticides and PCBs (μg/kg)							
Aldrin	1 / 13	13	4.24	2.4 - 32	2.4	Y	NAP
beta-BHC	1 / 13	13	3.81	2.4 - 32	0.22	N	SC
delta-BHC	2 / 13	13	3.86	2.4 - 32	1.2 - 2.3	N	SC
alpha-Chlordane	2 / 13	13	3.81	2.4 - 32	0.96 - 1.9	N	SC
gamma-Chlordane	7 / 13	13	2.54	2.4 - 32	0.13 - 2.8	N	SC
4,4'-DDD	7 / 13	13	8.55	4.6 - 62	1.0 - 37	Y	NAP
4,4'-DDE	9 / 13	13	8.64	4.6 - 62	0.78 - 20	Y	NAP
4,4'-DDT	3 / 13	13	6.80	4.6 - 62	0.66 - 9.6	Y	NAP
Dieldrin	5 / 13	13	8.0	4.6 - 62	0.30 - 10	Y	NAP
Endosulfan I	5 / 13	13	3.10	2.4 - 32	0.38 - 3.4	Y	NAP
Endosulfan II	2 / 13	13	7.09	4.6 - 62	0.38 - 0.50	Y	NAP
Endosulfan Sulfate	2 / 13	13	8.21	4.6 - 62	0.35 - 1.8	Y	NAP
Endrin	3 / 13	13	8.70	4.6 - 62	0.12 - 14	Y	NAP
Endrin Ketone	3 / 13	13	7.12	4.6 - 62	0.57 - 2.3	N	SC
Heptachlor Epoxide	6 / 13	13	2.84	2.4 - 32	0.30 - 0.74	N	SC
Methoxychlor	3 / 13	13	32.4	24 - 320	0.92 - 12	Y	NAP
Aroclor-1232	1 / 13	13	87.0	46 - 620	170	N	SC
Aroclor-1242	2 / 13	13	99.9	46 - 620	33 - 220	N	SC
Aroclor-1260	1 / 13	13	103	46 - 620	260	N	FD

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Inorganics (mg/kg)							
Aluminum	16 / 16	16	7,120	NU	1,145 - 26,300	Y	NAP
Arsenic	9 / 14	14	6.91	2.40 - 4.40	3.50 - 26.5	Y	NAP
Barium	16 / 16	16	67.5	NU	8.20 - 287	Y	NAP
Beryllium	5 / 10	10	0.807	0.100 - 0.690	0.970 - 3.20	Y	NAP
Cadmium	2 / 7	7	0.454	0.400 - 0.800	0.475 - 1.30	Y	NAP
Calcium	14 / 16	16	3,790	402 - 813	619 - 7,910	N	EAN
Chromium	2 / 8	8	19.4	7.90 - 15.8	57.7 - 64.6	Y	NAP
Cobalt	5 / 10	10	5.84	1.60 - 3.80	3.40 - 19.9	Y	NAP
Copper	12 / 12	12	46.0	NU	7.50 - 194	Y	NAP
Iron	16 / 16	16	9,850	NU	1,580 - 49,500	Y	NAP
Lead	16 / 16	16	75.0	NU	6.70 - 400	Y	NAP
Magnesium	16 / 16	16	2,050	NU	173 - 9,700	N	EAN
Manganese	16 / 16	16	229	NU	18.3 - 1,160	Y	NAP
Mercury	7 / 11	11	0.396	0.0700 - 0.130	0.100 - 1.30	Y	NAP
Nickel	3 / 8	8	15.6	2.90 - 8.80	20.1 - 46.7	Y	NAP
Potassium	9 / 13	13	947	126 - 593	303 - 4,600	N	EAN
Selenium	1 / 7	7	1.15	0.930 - 3.0	1.80	Y	NAP
Silver	1 / 7	7	1.04	1.0 - 2.0	2.30	Y	NAP
Sodium	2 / 9	9	534	113 - 376	1,830 - 2,185	N	EAN
Vanadium	13 / 13	13	19.2	NU	4.30 - 76.4	Y	NAP
Zinc	9 / 11	11	133	4.50 - 9.0	7.80 - 669	Y	NAP
Content Brook Wetland Group							
Volatile Organics (µg/kg)							
Acetone	4 / 13	13	28.0	12 - 100	7.0 - 112	Y	NAP
Benzene	6 / 13	13	13.6	12 - 65	3.0 - 33	N	SC
2-Butanone	3 / 14	14	18.9	12 - 65	27 - 79	Y	NAP
Chlorobenzene	2 / 13	13	13.2	12 - 65	7.0 - 39	N	SC
Ethylbenzene	4 / 13	13	46.3	12 - 32	14 - 440	N	FD
Methylene Chloride	1 / 13	13	11.7	12 - 65	18	N	FD
1,1,2,2-Tetrachloroethane	1 / 13	13	16.7	12 - 65	80	N	FD
Toluene	3 / 14	14	14.3	12 - 65	11 - 41	N	SC
Xylenes (total)	4 / 13	13	53.2	12 - 65	33 - 410	Y	NAP

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Semivolatile Organics (µg/kg)							
Acenaphthene	1 / 14	14	302	380 - 1,100	160	Y	NAP
Acenaphthylene	1 / 14	14	304	380 - 1,100	180	N	SC
Anthracene	2 / 14	14	281	380 - 1,000	42 - 370	N	SC
Benzo(a)anthracene	5 / 14	14	332	380 - 1,000	150 - 1,300	Y	NAP
Benzo(a)pyrene	5 / 13	13	317	380 - 1,000	130 - 1,100	Y	NAP
Benzo(b)fluoranthene	6 / 13	13	350	380 - 1,000	60 - 1,400	Y	NAP
Benzo(g,h,i)perylene	3 / 13	13	315	380 - 1,100	130 - 470	Y	NAP
Benzo(k)fluoranthene	3 / 13	13	392	380 - 1,100	220 - 1,300	Y	NAP
Bis(2-ethylhexyl)phthalate	4 / 14	14	268	380 - 1,100	58 - 240	N	SC
Carbazole	1 / 14	14	310	380 - 1,100	270	Y	NAP
Chrysene	5 / 14	14	358	380 - 1,000	140 - 1,500	Y	NAP
Dibenzo(a,h)anthracene	2 / 13	13	305	380 - 1,100	90 - 310	Y	NAP
Dibenzofuran	2 / 14	14	299	380 - 1,100	50 - 290	N	SC
Fluoranthene	8 / 14	14	461	380 - 1,000	23 - 3,300	Y	NAP
Fluorene	2 / 14	14	311	380 - 1,000	59 - 770	Y	NAP
Indeno(1,2,3-cd)pyrene	5 / 13	13	266	380 - 1,000	82 - 590	Y	NAP
2-Methylnaphthalene	3 / 14	14	270	380 - 1,100	40 - 130	Y	NAP
Naphthalene	10 / 14	14	169	380 - 410	19 - 450	Y	NAP
Phenanthrene	7 / 14	14	396	380 - 1,000	35 - 2,700	Y	NAP
Pyrene	9 / 14	14	455	380 - 1,000	17 - 3,100	Y	NAP
Pesticides and PCBs (µg/kg)							
Aldrin	1 / 14	14	1.48	2.0 - 5.5	0.31	N	SC
delta-BHC	1 / 14	14	1.59	2.0 - 5.5	0.16	N	SC
alpha-Chlordane	1 / 14	14	1.52	2.0 - 5.5	0.43	N	SC
gamma-Chlordane	5 / 14	14	1.07	2.0 - 5.2	0.18 - 0.87	N	SC
4,4'-DDD	5 / 14	14	3.77	3.8 - 10	0.34 - 16	Y	NAP
4,4'-DDE	8 / 14	14	2.89	3.8 - 10	0.16 - 6.4	Y	NAP
Dieldrin	3 / 14	14	2.47	3.8 - 10	0.54 - 2.7	Y	NAP
Endosulfan I	1 / 14	14	1.48	2.0 - 5.3	0.39	Y	NAP
Endosulfan II	2 / 14	14	3.35	3.8 - 10	0.34 - 9.4	Y	NAP
Endosulfan Sulfate	1 / 14	14	2.91	3.8 - 11	0.30	Y	NAP
Endrin	1 / 14	14	2.92	3.8 - 11	0.42	N	SC
Endrin Ketone	2 / 14	14	2.79	3.8 - 11	0.16 - 0.79	N	SC

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

Analyte	Frequency of Detection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason For Exclusion
Heptachlor	1 / 14	14	1.50	2.0 - 5.5	0.54	N	FD
Heptachlor Epoxide	4 / 14	14	1.06	2.0 - 5.2	0.19 - 0.33	Y	NAP
Methoxychlor	4 / 14	14	12.2	20 - 53	0.48 - 14	Y	NAP
Aroclor-1254	1 / 14	14	30.3	38 - 110	20	N	SC
Aroclor-1260	1 / 14	14	54.8	38 - 110	340	N	FD
Inorganics (mg/kg)							
Aluminum	14 / 14	14	7,550	NU	2,640 - 32,300	Y	NAP
Arsenic	14 / 14	14	42.8	NU	2.70 - 256	Y	NAP
Barium	14 / 14	14	62.8	NU	18.6 - 253	Y	NAP
Beryllium	1 / 14	14	0.254	0.0400 - 0.910	1.40	N	BKGD
Calcium	12 / 14	14	3,700	621 - 661	410 - 13,800	N	EAN
Chromium	4 / 14	14	11.7	4.60 - 11.9	14.7 - 56.5	Y	NAP
Cobalt	5 / 14	14	5.52	1.60 - 3.20	2.33 - 17.7	Y	NAP
Copper	3 / 14	14	12.7	2.0 - 17.5	35.1 - 49.3	Y	NAP
Iron	14 / 14	14	18,300	NU	3,810 - 76,300	Y	NAP
Lead	14 / 14	14	30.3	NU	3.70 - 101	Y	NAP
Magnesium	14 / 14	14	2,510	NU	557 - 10,500	N	EAN
Manganese	14 / 14	14	417	NU	79.2 - 2,080	Y	NAP
Mercury	7 / 14	14	0.109	0.0600 - 0.110	0.0600 - 0.250	N	BKGD
Nickel	2 / 14	14	7.1	2.60 - 10.6	24.0 - 39.2	Y	NAP
Potassium	13 / 14	14	1,380	169	342 - 7,400	N	EAN
Selenium	5 / 14	14	0.982	0.500 - 1.80	1.0 - 2.50	Y	NAP
Silver	2 / 14	14	1.15	0.800 - 2.10	1.80 - 6.70	Y	NAP
Sodium	2 / 14	14	469	124 - 1,880	1,770 - 1,810	N	EAN
Vanadium	14 / 14	14	18.8	NU	5.80 - 73.4	N	BKGD
Zinc	8 / 14	14	31.1	10.0 - 38.5	11.2 - 115	N	SC

NOTES:

1. The number of samples in which the contaminant was detected divided by the total number of samples analyzed.
2. The number of samples used in calculating the mean. This number may differ from the denominator of the frequency of detection, because non-detect samples with high detection limits were not included in calculating the mean.

NU = Not used; chemical was detected in all samples or non-detect samples were excluded from the data set due to high detection limits (one-half the detection was greater than the maximum detected concentration across all samples in the grouping).

NAP = Not applicable.

BKGD = Background comparison. See Table 7-9.

TABLE 7-3 (Continued). SUMMARY OF CHEMICALS DETECTED IN SEDIMENT AT IRON HORSE PARK

NOTES (Continued):

FD = Frequency of detection. See Table 7-6.

SC = Screening criterion. See Table 7-9.

EAN = Essential animal nutrient.

TABLE 7-4. SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
West Middlesex Canal Group							
Pesticides and PCBs (ug/l) - June 1993							
Aldrin	1 / 6	6	0.00115	0.0025	0.00064	Y	NAP
gamma-BHC(Lindane)	1 / 6	6	0.00121	0.0025	0.0010	N	SC
alpha-Chlordane	2 / 6	6	0.00110	0.0025	0.00063 - 0.00098	N	SC
Dieldrin	1 / 6	6	0.00245	0.0050	0.0022	N	FD
Endrin	2 / 6	6	0.00305	0.0050	0.0032 - 0.0051	N	FD
Heptachlor Epoxide	2 / 6	6	0.00140	0.0025	0.0015 - 0.0019	N	FD
Methoxychlor	1 / 6	6	0.0109	0.025	0.0029	N	SC
Pesticides and PCBs (ug/l) - September 1993							
delta-BHC	1 / 5	5	0.00440	0.0030	0.016	N	FD
Aroclor-1248	1 / 5	5	0.0540	0.050	0.17	N	FD
Inorganics (ug/l) - June 1993							
Aluminum	4 / 6	6	705	83.9 - 111	469 - 1,610	N	BKGD
Arsenic	1 / 6	6	6.18	2.30 - 12.3	22.1	N	SC
Barium	6 / 6	6	35.9	NU	21.9 - 55.7	N	BKGD
Calcium	6 / 6	6	13,800	NU	12,900 - 14,600	N	BKGD
Chromium	1 / 6	6	2.56	3.30	7.10	N	BKGD
Iron	6 / 6	6	5,410	NU	1,430 - 12,450	N	BKGD
Lead	2 / 6	6	9.47	2.80 - 11.2	21.8 - 21.9	N	BKGD
Magnesium	6 / 6	6	2,830	NU	2,630 - 3,040	N	BKGD
Manganese	6 / 6	6	748	NU	492 - 1,160	N	BKGD
Nickel	6 / 6	6	5.77	NU	4.30 - 6.70	N	BKGD
Potassium	6 / 6	6	4,520	NU	2,840 - 12,000	N	EAN
Sodium	6 / 6	6	29,000	NU	26,100 - 31,600	N	BKGD
Zinc	2 / 6	6	17.5	7.20 - 17.9	30.8 - 49.3	N	BKGD
Inorganics (ug/l) - September 1993							
Aluminum	4 / 5	5	804	53.3	193 - 1,730	N	BKGD
Arsenic	2 / 5	5	18.1	2.10 - 8.30	38.8 - 43.3	N	SC
Barium	5 / 5	5	52.4	NU	31.1 - 99.8	N	BKGD
Calcium	5 / 5	5	13,200	NU	11,800 - 14,050	N	BKGD

TABLE 7-4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Chromium	1 / 5	5	1.77	1.80 - 2.10	4.80	N	BKGD
Iron	5 / 5	5	6,710	NU	1,690 - 15,500	N	BKGD
Lead	2 / 5	5	9.47	3.10 - 10.9	10.9 - 27.8	N	BKGD
Magnesium	5 / 5	5	2,390	NU	2,270 - 2,495	N	BKGD
Manganese	5 / 5	5	1,260	NU	349 - 3,530	N	BKGD
Potassium	5 / 5	5	3,210	NU	2,950 - 3,590	N	BKGD
Sodium	5 / 5	5	28,500	NU	25,500 - 31,300	N	EAN
Thallium	1 / 5	5	1.17	1.60 - 2.20	2.05	N	BKGD
Vanadium	1 / 5	5	2.78	2.30 - 5.50	4.50	N	BKGD
Zinc	1 / 5	5	32.0	10.1 - 46.2	109	N	BKGD
Wetland 2 Group							
Volatile Organics (ug/l) - June 1993							
1,2-Dichloroethene(total)	1 / 15	15	5.40	10	11	N	FD
Tetrachloroethene	1 / 15	15	5.73	10	16	N	FD
1,1,1-Trichloroethane	1 / 15	15	6.0	10	20	N	FD
Trichloroethene	1 / 15	15	5.20	10	8.0	N	FD
Volatile Organics (ug/l) - September 1993							
Carbon Disulfide	1 / 14	14	5.0	10	5.0	N	SC
Chlorobenzene	1 / 14	14	4.79	10	2.0	N	FD
1,1-Dichloroethane	2 / 14	14	5.18	10	2.0 - 11	N	SC
1,2-Dichloroethene(total)	1 / 14	14	5.46	10	12	N	FD
Methylene Chloride	1 / 14	14	5.36	10	10	N	FD
Tetrachloroethene	2 / 14	14	5.29	10	2.0 - 12	N	SC
1,1,1-Trichloroethane	5 / 14	14	4.93	10	1.0 - 17	N	SC
Trichloroethene	1 / 14	14	5.25	10	8.5	N	FD
Semivolatile Organics (ug/l) - June 1993							
Acenaphthene	1 / 15	15	4.70	10	0.50	N	FD
Benzo(b)fluoranthene	1 / 15	15	4.73	10	1.0	N	FD
Bis(2-ethylhexyl)phthalate	2 / 15	15	4.43	10	0.50 - 1.0	N	SC
Fluoranthene	1 / 15	15	4.71	10	0.70	N	SC
Phenanthrene	1 / 15	15	4.72	10	0.80	N	SC
Pyrene	2 / 15	15	4.47	10	1.0	Y	NAP

TABLE 7-4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Semivolatile Organics (ug/l) - September 1993							
Pyrene	1 / 14	14	4.71	10	1.0	Y	NAP
Pesticides and PCBs (ug/l) - June 1993							
Aldrin	1 / 15	15	0.00121	0.0025	0.00069	Y	NAP
alpha-BHC	2 / 15	15	0.00128	0.0025	0.0010 - 0.0020	N	SC
gamma-BHC(Lindane)	2 / 15	15	0.00174	0.0025	0.0024 - 0.0074	N	SC
alpha-Chlordane	1 / 15	15	0.00125	0.0025	0.0012	N	SC
4,4'-DDD	1 / 15	15	0.00269	0.0050	0.0053	N	FD
4,4'-DDT	1 / 15	15	0.00247	0.0050	0.0020	N	FD
Endosulfan II	2 / 15	15	0.00231	0.0050	0.0011	N	SC
Endrin	6 / 15	15	0.00482	0.0050	0.0026 - 0.021	N	SC
Endrin Aldehyde	2 / 15	15	0.00267	0.0050	0.0026 - 0.0050	N	FD
Pesticides and PCBs (ug/l) - September 1993							
Endrin Aldehyde	1 / 13	13	0.00269	0.0050	0.0050	N	SC
Inorganics (ug/l) - June 1993							
Aluminum	8 / 15	15	570	47.7 - 153	301 - 2,460	N	BKGD
Arsenic	7 / 15	15	10.3	1.70 - 7.70	1.80 - 71.0	N	SC
Barium	15 / 15	15	61.3	NU	25.2 - 156	Y	NAP
Calcium	15 / 15	15	20,100	NU	6,160 - 31,800	N	EAN
Chromium	2 / 15	15	3.16	3.30 - 5.80	6.90 - 11.5	Y	NAP
Cobalt	4 / 15	15	4.01	2.90 - 5.0	5.50 - 22.5	N	BKGD
Copper	2 / 15	15	7.75	2.70 - 32.2	26.5 - 29.8	Y	NAP
Iron	15 / 15	15	10,200	NU	662 - 53,300	Y	NAP
Lead	7 / 15	15	16.3	2.40 - 11.6	16.6 - 59.1	Y	NAP
Magnesium	15 / 15	15	3,530	NU	1,260 - 5,530	N	EAN
Manganese	15 / 15	15	1,410	NU	330 - 4,810	N	BKGD
Mercury	2 / 15	15	0.0653	0.100	0.150 - 0.180	Y	NAP
Nickel	7 / 15	15	4.84	4.20 - 6.10	4.80 - 9.40	N	BKGD
Potassium	15 / 15	15	2,870	NU	1,600 - 4,410	N	EAN
Selenium	4 / 15	15	1.88	2.30 - 3.30	2.40 - 3.60	N	SC
Sodium	15 / 15	15	70,800	NU	10,100 - 205,000	N	EAN
Vanadium	3 / 15	15	2.33	2.10 - 3.30	5.0 - 8.50	N	BKGD

TABLE 7-4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Zinc	8 / 15	15	36.1	6.70 - 21.9	17.2 - 165	Y	NAP
Inorganics (ug/l) - September 1993							
Aluminum	10 / 14	14	660	68.4 - 158	108 - 6,200	N	BKGD
Arsenic	4 / 14	14	14.9	2.10 - 8.40	9.0 - 155	N	SC
Barium	14 / 14	14	99.2	NU	20.1 - 842	Y	NAP
Cadmium	1 / 14	14	2.66	1.0 - 1.50	28.2	N	FD
Calcium	14 / 14	14	21,700	NU	7,280 - 56,300	N	EAN
Chromium	4 / 14	14	5.51	1.80 - 2.60	3.40 - 36.9	Y	NAP
Cobalt	1 / 14	14	3.21	1.60 - 4.70	27.7	N	BKGD
Copper	1 / 14	14	49.9	2.50 - 32.0	636	Y	NAP
Iron	14 / 14	14	8,880	NU	528 - 90,500	Y	NAP
Lead	4 / 14	14	54.2	2.90 - 13.9	15.1 - 630	Y	NAP
Magnesium	14 / 14	14	3,560	NU	1,610 - 11,700	N	EAN
Manganese	14 / 14	14	733	NU	145 - 1,680	N	BKGD
Nickel	1 / 14	14	25.2	3.40 - 6.30	324	Y	NAP
Potassium	14 / 14	14	3,550	NU	2,430 - 7,570	N	EAN
Silver	1 / 14	14	1.91	2.60 - 3.70	6.50	Y	NAP
Sodium	14 / 14	14	72,400	NU	12,600 - 153,500	N	EAN
Thallium	2 / 14	14	1.29	1.60 - 3.80	2.30 - 2.90	N	BKGD
Vanadium	2 / 14	14	4.59	2.30 - 5.50	3.40 - 38.9	Y	NAP
Zinc	4 / 14	14	383	10.3 - 45.6	37.7 - 5,100	Y	NAP
East Middlesex Canal Group							
Semivolatile Organics (ug/l) - June 1993							
Bis(2-ethylhexyl)phthalate	1 / 6	6	4.28	10	0.70	N	SC
Pesticides and PCBs (ug/l) - June 1993							
gamma-BHC(Lindane)	2 / 6	6	0.00145	0.0025	0.0016 - 0.0021	N	SC
Methoxychlor	1 / 6	6	0.0146	0.025	0.025	Y	NA
Inorganics (ug/l) - June 1993							
Aluminum	1 / 6	6	79.2	46.1 - 100	299	N	BKGD
Arsenic	5 / 6	6	3.27	2.80	2.70 - 5.50	N	BKGD
Barium	6 / 6	6	39.6	NU	9.30 - 54.5	N	BKGD
Calcium	6 / 6	6	17,900	NU	3,330 - 21,900	N	EAN

TABLE 7-4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Iron	6 / 6	6	1,780	NU	1,050 - 2,050	N	BKGD
Magnesium	6 / 6	6	3,330	NU	942 - 3,990	N	EAN
Manganese	5 / 6	6	1,520	18.2	1,400 - 2,250	N	BKGD
Potassium	6 / 6	6	2,500	NU	996 - 3,070	N	EAN
Sodium	6 / 6	6	54,500	NU	18,600 - 67,100	N	EAN
Inorganics (ug/l) - September 1993							
Aluminum	2 / 6	6	54.0	15.5 - 83.0	17.4 - 188	N	BKGD
Antimony	1 / 6	6	6.54	9.20 - 12.9	14.4	N	SC
Barium	5 / 6	6	40.3	16.3	40.2 - 53.2	N	BKGD
Calcium	6 / 6	6	18,500	NU	11,400 - 20,900	N	EAN
Copper	1 / 6	6	1.76	2.50 - 2.90	3.70	N	BKGD
Iron	6 / 6	6	1,180	NU	329 - 1,850	N	BKGD
Magnesium	6 / 6	6	3,630	NU	3,410 - 4,090	N	EAN
Manganese	6 / 6	6	807	NU	93.7 - 1,380	N	BKGD
Potassium	6 / 6	6	3,140	NU	1,520 - 3,690	N	EAN
Sodium	6 / 6	6	61,700	NU	28,500 - 70,300	N	EAN
Zinc	1 / 6	6	7.08	8.50 - 16.3	12.9	N	BKGD
Richardson Pond Group							
Volatile Organics (ug/l) - June 1993							
Xylenes (total)	1 / 8	8	6.0	10	13	N	SC
Volatile Organics (ug/l) - September 1993							
Benzene	1 / 7	7	4.43	10	1.0	N	SC
Chloromethane	1 / 7	7	4.71	10	3.0	N	FD
Toluene	2 / 7	7	5.14	10	1.0 - 10	N	SC
Semivolatile Organics (ug/l) - June 1993							
Acenaphthene	1 / 8	8	4.49	10	0.90	N	FD
Fluoranthene	2 / 8	8	3.88	10	0.40 - 0.60	N	SC
Naphthalene	3 / 8	8	3.38	10	0.40 - 1.0	N	SC
Phenanthrene	2 / 8	8	3.88	10	0.40 - 0.60	N	SC
Pyrene	2 / 8	8	3.95	10	0.60 - 1.0	Y	NAP
Semivolatile Organics (ug/l) - September 1993							
Chrysene	1 / 7	7	4.43	10	1.0	N	FD

TABLE 7-4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Fluoranthene	1 / 7	7	4.57	10	2.0	N	FD
Phenanthrene	1 / 7	7	4.43	10	1.0	N	FD
Pyrene	1 / 7	7	4.57	10	2.0	Y	NAP
Pesticides and PCBs (ug/l) - June 1993							
gamma-Chlordane	2 / 8	8	0.00175	0.0025	0.0022 - 0.0043	N	SC
Endosulfan I	3 / 8	8	0.00126	0.0025	0.0011 - 0.0014	N	SC
Endosulfan II	4 / 8	8	0.00225	0.0050	0.0017 - 0.0022	N	SC
Endrin	5 / 8	8	0.00355	0.0050	0.0017 - 0.012	N	SC
Pesticides and PCBs (ug/l) - September 1993							
alpha-Chlordane	1 / 7	7	0.00189	0.0030	0.0043	N	SC
gamma-Chlordane	1 / 7	7	0.00196	0.0030	0.0048	N	FD
4,4'-DDD	1 / 7	7	0.00564	0.0050	0.025	Y	NAP
4,4'-DDT	1 / 7	7	0.00289	0.0050	0.0053	N	SC
Endosulfan II	1 / 7	7	0.00279	0.0050	0.0045	N	FD
Endrin Aldehyde	1 / 7	7	0.00325	0.0050	0.0078	N	SC
Aroclor-1260	1 / 7	7	0.0557	0.050	0.24	N	FD
Inorganics (ug/l) - June 1993							
Aluminum	5 / 8	8	662	33.3 - 97.7	129 - 2,990	N	BKGD
Arsenic	7 / 8	8	18.7	2.80	2.90 - 59.8	N	SC
Barium	8 / 8	8	103	NU	17.1 - 414	Y	NAP
Calcium	8 / 8	8	19,800	NU	11,700 - 38,200	N	EAN
Chromium	2 / 8	8	2.65	3.30	4.30 - 7.0	N	BKGD
Cobalt	1 / 8	8	2.09	2.90	6.60	Y	NAP
Iron	8 / 8	8	26,300	NU	1,200 - 137,000	Y	NAP
Lead	2 / 8	8	21.6	2.10 - 5.70	24.5 - 138	Y	NAP
Magnesium	8 / 8	8	4,760	NU	3,040 - 11,100	N	EAN
Manganese	8 / 8	8	862	NU	149 - 3,750	N	BKGD
Mercury	1 / 8	8	0.0638	0.100	0.160	Y	NAP
Nickel	3 / 8	8	3.49	4.20	4.50 - 7.30	N	BKGD
Potassium	8 / 8	8	8,110	NU	3,330 - 29,400	N	EAN
Silver	1 / 8	8	3.22	3.30	14.2	Y	NAP
Sodium	8 / 8	8	38,700	NU	32,100 - 42,900	N	EAN

TABLE 7-4 (Continued). *SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE*

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Vanadium	3 / 8	8	3.18	2.10	2.80 - 14.4	N	BKGD
Zinc	1 / 8	8	28.9	4.80 - 37.7	193	Y	NAP
Inorganics (ug/l) - September 1993							
Aluminum	3 / 7	7	6,830	11.5 - 85.9	2,760 - 41,700	Y	NAP
Antimony	1 / 7	7	7.52	12.9	14.0	N	SC
Arsenic	3 / 7	7	22.5	2.10	34.6 - 61.3	N	SC
Barium	7 / 7	7	163	NU	17.2 - 802	Y	NAP
Beryllium	1 / 7	7	0.332	0.200 - 0.360	1.60	Y	NAP
Calcium	7 / 7	7	21,100	NU	14,000 - 41,800	N	EAN
Chromium	1 / 7	7	14.6	2.10 - 6.70	92.3	Y	NAP
Cobalt	3 / 7	7	5.71	2.60	4.30 - 25.6	N	BKGD
Copper	1 / 7	7	47.0	2.50 - 28.1	299	Y	NAP
Iron	7 / 7	7	31,400	NU	679 - 116,150	Y	NAP
Lead	3 / 7	7	92.9	2.90 - 3.10	60.9 - 517	Y	NAP
Magnesium	7 / 7	7	6,060	NU	3,120 - 17,250	N	EAN
Manganese	7 / 7	7	566	NU	112 - 1,130	N	BKGD
Potassium	7 / 7	7	5,370	NU	1,160 - 12,000	N	EAN
Selenium	2 / 7	7	2.44	2.80	4.0 - 6.10	Y	NAP
Silver	2 / 7	7	2.96	2.60	5.10 - 9.15	Y	NAP
Sodium	7 / 7	7	37,000	NU	28,100 - 40,500	N	EAN
Vanadium	3 / 7	7	19.8	5.50	11.2 - 102	Y	NAP
Zinc	2 / 7	7	412	6.70 - 51.2	58.7 - 2,780	Y	NAP
Content Brook Wetland Group							
Volatile Organics (ug/l) - June 1993							
Ethylbenzene	1 / 7	7	10.3	10	42	N	FD
Toluene	1 / 7	7	5.43	10	8.0	N	FD
Xylenes (total)	2 / 7	7	23.3	10	18 - 120	Y	NAP
Volatile Organics (ug/l) - September 1993							
Benzene	1 / 7	7	4.43	10	1.0	N	SC
Carbon Disulfide	1 / 7	7	4.43	10	1.0	N	SC
Toluene	1 / 7	7	5.0	10	5.0	N	SC
Xylenes (total)	1 / 7	7	4.86	10	4.0	N	FD

TABLE 7-4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Semivolatile Organics (ug/l) - June 1993							
Benzo(a)anthracene	1 / 7	7	4.43	10	1.0	N	FD
Benzo(b)fluoranthene	1 / 7	7	4.57	10	2.0	N	FD
Chrysene	1 / 7	7	4.43	10	1.0	N	FD
1,4-Dichlorobenzene	1 / 7	7	4.57	10	2.0	N	FD
2,4-Dimethylphenol	1 / 7	7	5.29	10	7.0	N	FD
Fluoranthene	1 / 7	7	4.43	10	1.0	N	SC
4-Methylphenol	2 / 7	7	72.6	10	43 - 440	N	FD
Naphthalene	4 / 7	7	3.37	10	0.60 - 4.0	N	SC
Phenanthrene	1 / 7	7	4.43	10	1.0	N	SC
Phenol	1 / 7	7	18.0	10	96	N	FD
Pyrene	1 / 7	7	4.43	10	1.0	Y	NAP
Semivolatile Organics (ug/l) - September 1993							
1,4-Dichlorobenzene	1 / 7	7	4.43	10	1.0	N	FD
Pesticides and PCBs (ug/l) - June 1993							
Aldrin	1 / 7	7	0.00307	0.0025	0.014	Y	NAP
alpha-BHC	1 / 7	7	0.00129	0.0025	0.0015	N	SC
gamma-BHC(Lindane)	3 / 7	7	0.0146	0.0025	0.012 - 0.066	N	SC
gamma-Chlordane	1 / 7	7	0.00177	0.0025	0.0049	Y	NAP
4,4'-DDD	1 / 7	7	0.00296	0.0050	0.0057	N	FD
4,4'-DDT	1 / 7	7	0.00269	0.0050	0.0038	N	FD
Endrin	4 / 7	7	0.00299	0.0050	0.0017 - 0.0046	N	SC
Pesticides and PCBs (ug/l) - September 1993							
alpha-BHC	2 / 7	7	0.00236	0.0030	0.0030 - 0.0060	N	SC
alpha-Chlordane	1 / 7	7	0.00200	0.0030	0.0050	Y	NAP
4,4'-DDD	1 / 7	7	0.00271	0.0050	0.0040	N	SC
4,4'-DDT	1 / 7	7	0.00314	0.0050	0.0070	N	SC
Inorganics (ug/l) - June 1993							
Aluminum	4 / 7	7	12,100	57.9 - 98.1	234 - 65,000	Y	NAP
Antimony	2 / 7	7	13.7	17.9 - 18.6	20.2 - 30.2	N	FD
Arsenic	6 / 7	7	2,320	2.80	2.00 - 13,000	Y	NAP
Barium	7 / 7	7	2,270	NU	24.2 - 10,300	Y	NAP

TABLE 7-4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Calcium	7 / 7	7	90,800	NU	15,000 - 226,000	N	EAN
Chromium	3 / 7	7	29.1	3.30 - 5.80	9.70 - 133	Y	NAP
Cobalt	2 / 7	7	16.0	2.90 - 3.80	51.6	Y	NAP
Copper	1 / 7	7	18.7	2.70 - 4.20	120	Y	NAP
Iron	7 / 7	7	357,000	NU	653 - 1,290,000	Y	NAP
Lead	2 / 7	7	40.3	1.10 - 4.20	64.3 - 211	Y	NAP
Magnesium	7 / 7	7	26,300	NU	3,380 - 75,300	N	EAN
Manganese	7 / 7	7	3,500	NU	633 - 13,500	Y	NAP
Nickel	4 / 7	7	32.2	4.20 - 6.10	5.90 - 118	Y	NAP
Potassium	7 / 7	7	44,000	NU	2,860 - 113,000	N	EAN
Selenium	3 / 7	7	8.20	2.30 - 2.40	2.50 - 27.6	Y	NAP
Silver	2 / 7	7	15.4	3.30 - 3.80	44.7 - 54.0	Y	NAP
Sodium	7 / 7	7	158,000	NU	39,100 - 333,000	N	EAN
Thallium	1 / 7	7	4.36	1.10 - 3.60	23.8	N	FD
Vanadium	3 / 7	7	49.8	2.10 - 3.30	7.30 - 211	Y	NAP
Zinc	4 / 7	7	123	3.40 - 4.80	14.6 - 530	Y	NAP
Inorganics (ug/l) - September 1993							
Aluminum	5 / 7	7	2,410	60.6 - 98.2	94.8 - 12,500	Y	NAP
Arsenic	6 / 7	7	181	4.40	2.50 - 676	Y	NAP
Barium	7 / 7	7	234	NU	44.3 - 595	Y	NAP
Beryllium	1 / 7	7	0.143	0.200	0.400	N	BKGD
Calcium	7 / 7	7	48,000	NU	20,600 - 98,800	N	EAN
Chromium	3 / 7	7	6.56	2.10 - 4.10	5.60 - 23.4	Y	NAP
Cobalt	3 / 7	7	3.96	2.60 - 3.0	5.30 - 9.30	N	BKGD
Copper	1 / 7	7	6.61	2.50 - 11.9	31.8	Y	NAP
Iron	7 / 7	7	27,100	NU	1,420 - 77,200	Y	NAP
Lead	3 / 7	7	89.6	4.80 - 8.30	18.6 - 551	Y	NAP
Magnesium	7 / 7	7	20,300	NU	3,770 - 50,200	N	EAN
Manganese	7 / 7	7	1,410	NU	752 - 2,580	N	BKGD
Nickel	3 / 7	7	21.6	3.40 - 6.60	28.4 - 63.6	N	BKGD
Potassium	7 / 7	7	42,500	NU	3,960 - 130,000	N	EAN
Sodium	7 / 7	7	168,000	NU	64,800 - 444,000	N	EAN
Vanadium	3 / 7	7	8.07	2.60 - 5.50	6.80 - 29.3	Y	NAP

TABLE 7-4 (Continued). SUMMARY OF CHEMICALS DETECTED IN SURFACE WATER AT IRON HORSE

Analyte	Frequency of Dectection (1)	Sample Size (2)	Arithmetic Mean	Range of Detection Limits	Range of Detected Concentrations	COPC Y/N	Reason for Exclusion
Zinc	1 / 7	7	30.7	15.9 - 48.4	116	N	BKGD

NOTES:

1. The number of samples in which the contaminant was detected divided by the total number of samples analyzed.
2. The number of samples used in calculating the mean. This number may differ from the denominator of the frequency of detection, because non-detect samples with high detection limits were not included in calculating the mean.

NU = Not used; chemical was detected in all samples or non-detect samples were excluded from the data set due to high detection limits (one-half the detection was greater than the maximum detected concentration across all samples in the grouping).

NAP = Not applicable.

BKGD = Background comparison. See Table 7-10.

FD = Frequency of detection. See Table 7-7.

SC = Screening criterion. See Tables 7-10 and 7-11.

EAN = Essential animal nutrient.

TABLE 7-5. WHOLE SITE FREQUENCY FOR SURFACE SOILS

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Volatile Organics (µg/kg)			
Acetone	15 / 77	19.5	
2-Butanone	1 / 77	1.30	X
Carbon Disulfide	1 / 77	1.30	X
Chloroethane	4 / 77	5.19	
Methylene Chloride	46 / 77	59.7	
Semivolatile Organics (µg/kg)			
Acenaphthene	9 / 76	11.8	
Acenaphthylene	33 / 77	42.9	
Anthracene	40 / 77	51.9	
Benzo(a)anthracene	54 / 76	71.1	
Benzo(a)pyrene	53 / 76	69.7	
Benzo(b)fluoranthene	63 / 76	82.9	
Benzo(g,h,i)perylene	41 / 76	53.9	
Benzo(k)fluoranthene	4 / 75	5.33	
bis(2-Chloroethyl) ether	1 / 76	1.32	X
Bis(2-ethylhexyl)phthalate	21 / 75	28.0	
Butylbenzylphthalate	5 / 75	6.67	
Carbazole	25 / 77	32.5	
Chrysene	59 / 76	77.6	
Di-n-butylphthalate	2 / 76	2.63	X
Dibenzo(a,h)anthracene	19 / 76	25.0	
Dibenzofuran	24 / 77	31.2	
2,4-Dimethylphenol	1 / 76	1.32	X
Fluoranthene	67 / 77	87.0	
Fluorene	11 / 77	14.3	
Indeno(1,2,3-cd)pyrene	47 / 76	61.8	
Isophorone	1 / 76	1.32	X
Naphthalene	37 / 77	48.1	
2-Methylnaphthalene	42 / 77	54.5	
2-Methylphenol	1 / 76	1.32	X
4-Methylphenol	3 / 76	3.95	X
Pentachlorophenol	9 / 77	11.7	
Phenanthrene	60 / 77	77.9	

TABLE 7-5 (Continued). WHOLE SITE FREQUENCY FOR SURFACE SOILS

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Phenol	7 / 76	9.21	
Pyrene	67 / 76	88.2	
Pesticides and PCBs (µg/kg)			
Aldrin	52 / 77	67.5	
alpha-BHC	22 / 74	29.7	
beta-BHC	8 / 74	10.8	
delta-BHC	2 / 73	2.74	X
gamma-BHC(Lindane)	19 / 75	25.3	
alpha-Chlordane	27 / 74	36.5	
gamma-Chlordane	45 / 76	59.2	
Dieldrin	12 / 73	16.4	
4,4'-DDD	70 / 77	90.9	
4,4'-DDE	60 / 76	78.9	
4,4'-DDT	68 / 77	88.3	
Endosulfan I	7 / 73	9.59	
Endosulfan II	30 / 73	41.1	
Endosulfan Sulfate	27 / 74	36.5	
Endrin	52 / 74	70.3	
Endrin Aldehyde	19 / 73	26.0	
Endrin Ketone	46 / 74	62.2	
Heptachlor	6 / 73	8.22	
Heptachlor Epoxide	40 / 75	53.3	
Methoxychlor	32 / 75	42.7	
Aroclor-1016	1 / 73	1.37	X
Inorganics (mg/kg)			
Aluminum	77 / 77	100	
Antimony	19 / 77	24.7	
Arsenic	77 / 77	100	
Barium	77 / 77	100	
Beryllium	2 / 77	2.60	X
Cadmium	18 / 77	23.4	
Calcium	75 / 77	97.4	
Chromium	69 / 77	89.6	
Cobalt	73 / 77	94.8	

TABLE 7-5 (Continued). WHOLE SITE FREQUENCY FOR SURFACE SOILS

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Copper	75 / 77	97.4	
Cyanide	18 / 77	23.4	
Iron	77 / 77	100	
Lead	76 / 77	98.7	
Magnesium	77 / 77	100	
Manganese	77 / 77	100	
Mercury	41 / 77	53.2	
Nickel	46 / 77	59.7	
Potassium	41 / 77	53.2	
Selenium	24 / 77	31.2	
Silver	2 / 61	3.28	X
Sodium	1 / 77	1.30	X
Thallium	1 / 77	1.30	X
Vanadium	77 / 77	100	
Zinc	77 / 77	100	

NOTES:

1. Those chemicals detected below 5% for the whole site were eliminated as COPC.

TABLE 7-6. WHOLE SITE FREQUENCY FOR SEDIMENT

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Volatile Organics (µg/kg)			
Acetone	20 / 46	43.5	
Benzene	5 / 46	10.9	
Bromomethane	1 / 46	2.2	X
2-Butanone	17 / 46	37.0	
Chlorobenzene	3 / 46	6.52	
Chloromethane	1 / 46	2.17	X
1,2-Dichloroethene(total)	1 / 46	2.17	X
Ethylbenzene	2 / 46	4.35	X
Methylene Chloride	1 / 46	2.17	X
Toluene	10 / 46	21.7	
1,1,1-Trichloroethane	1 / 46	2.17	X
1,1,2,2-Tetrachloroethane	2 / 46	4.35	X
Xylenes (total)	6 / 46	13.0	
Semivolatile Organics (µg/kg)			
Acenaphthene	11 / 46	23.9	
Acenaphthylene	4 / 46	8.70	
Anthracene	13 / 46	28.3	
Benzo(a)anthracene	22 / 46	47.8	
Benzo(a)pyrene	20 / 46	43.5	
Benzo(b)fluoranthene	27 / 46	58.7	
Benzo(g,h,i)perylene	11 / 46	23.9	
Benzo(k)fluoranthene	17 / 46	37.0	
bis(2-Chloroethyl) ether	1 / 46	2.17	X
Bis(2-ethylhexyl)phthalate	23 / 46	50.0	
Butylbenzylphthalate	5 / 46	10.9	
Carbazole	6 / 46	13.0	
Chrysene	29 / 46	63.0	
Dibenzo(a,h)anthracene	7 / 46	15.2	
Dibenzofuran	12 / 46	26.1	
1,2-Dichlorobenzene	1 / 46	2.17	X
1,4-Dichlorobenzene	1 / 46	2.17	X
Fluoranthene	34 / 46	73.9	
Fluorene	13 / 46	28.3	

TABLE 7-6 (Continued). WHOLE SITE FREQUENCY FOR SEDIMENT

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Indeno(1,2,3-cd)pyrene	13 / 46	28.3	
2-Methylnaphthalene	14 / 46	30.4	
4-Methylphenol	11 / 46	23.9	
Naphthalene	20 / 46	43.5	
N-Nitrosodiphenylamine	4 / 46	8.70	
Phenanthrene	30 / 46	65.2	
Pyrene	34 / 46	73.9	
Pesticides and PCBs (μg/kg)			
Aldrin	4 / 46	8.70	
alpha-BHC	3 / 46	6.52	
beta-BHC	3 / 46	6.52	
delta-BHC	8 / 46	17.4	
gamma-BHC(Lindane)	2 / 46	4.35	X
alpha-Chlordane	12 / 46	26.1	
gamma-Chlordane	21 / 46	45.7	
4,4'-DDD	35 / 46	76.1	
4,4'-DDE	43 / 46	93.5	
4,4'-DDT	5 / 46	10.9	
Dieldrin	28 / 46	60.9	
Endosulfan I	13 / 46	28.3	
Endosulfan II	13 / 46	28.3	
Endosulfan Sulfate	5 / 46	10.9	
Endrin	16 / 46	34.8	
Endrin Aldehyde	3 / 46	6.52	
Endrin Ketone	6 / 46	13.0	
Heptachlor	1 / 46	2.17	X
Heptachlor Epoxide	18 / 46	39.1	
Methoxychlor	13 / 46	28.3	
Aroclor-1016	1 / 46	2.17	X
Aroclor-1232	3 / 46	6.52	
Aroclor-1242	7 / 46	15.2	
Aroclor-1248	13 / 46	28.3	
Aroclor-1254	3 / 46	6.52	
Aroclor-1260	2 / 46	4.35	X

TABLE 7-6 (Continued). WHOLE SITE FREQUENCY FOR SEDIMENT

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Inorganics (mg/kg)			
Aluminum	46 / 46	100	
Antimony	5 / 40	12.5	
Arsenic	43 / 45	95.6	
Barium	46 / 46	100	
Beryllium	12 / 44	27.3	
Cadmium	6 / 41	14.6	
Calcium	46 / 46	100	
Chromium	19 / 42	45.2	
Cobalt	32 / 42	76.2	
Copper	36 / 45	80.0	
Cyanide	1 / 40	2.50	X
Iron	46 / 46	100	
Lead	46 / 46	100	
Magnesium	46 / 46	100	
Manganese	46 / 46	100	
Mercury	27 / 46	58.7	
Nickel	14 / 41	34.1	
Potassium	43 / 44	97.7	
Selenium	23 / 41	56.1	
Silver	5 / 40	12.5	
Sodium	6 / 43	14.0	
Vanadium	45 / 45	100	
Zinc	41 / 44	93.2	

NOTES:

1. Those chemicals detected below 5% for the whole site were eliminated as COPC.

TABLE 7-7. WHOLE SITE FREQUENCY FOR SURFACE WATER

Analyte	Whole Site Frequency	%	X (if <5%)(1)
June 1993			
Volatile Organics (µg/l)			
1,2-Dichloroethene(total)	1 / 42	2.38	X
Ethylbenzene	1 / 42	2.38	X
Tetrachloroethene	1 / 42	2.38	X
Toluene	1 / 42	2.38	X
1,1,1-Trichloroethane	1 / 42	2.38	X
Trichloroethene	1 / 42	2.38	X
Xylenes (total)	3 / 42	7.14	
Semivolatile Organics (µg/l)			
Bis(2-ethylhexyl)phthalate	3 / 42	7.14	
Chrysene	1 / 42	2.38	X
1,4-Dichlorobenzene	1 / 42	2.38	X
2,4-Dimethylphenol	1 / 42	2.38	X
4-Methylphenol	2 / 42	4.76	X
Acenaphthene	2 / 42	4.76	X
Benzo(a)anthracene	1 / 42	2.38	X
Benzo(b)fluoranthene	2 / 42	4.76	X
Fluoranthene	4 / 42	9.52	
Naphthalene	7 / 42	16.7	
Phenanthrene	4 / 42	9.52	
Phenol	1 / 42	2.38	X
Pyrene	5 / 42	11.9	
Pesticides and PCBs (µg/l)			
Aldrin	3 / 42	7.14	
alpha-BHC	3 / 42	7.14	
gamma-BHC(Lindane)	8 / 41	19.5	
alpha-Chlordane	3 / 42	7.14	
gamma-Chlordane	3 / 42	7.14	
4,4'-DDD	2 / 42	4.76	X
4,4'-DDT	2 / 42	4.76	X
Dieldrin	1 / 42	2.38	X
Endosulfan I	3 / 42	7.14	
Endosulfan II	6 / 42	14.3	

TABLE 7-7 (Continued). WHOLE SITE FREQUENCY FOR SURFACE WATER

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Endrin	17 / 42	40.5	
Endrin Aldehyde	2 / 42	4.76	X
Heptachlor Epoxide	2 / 42	4.76	X
Methoxychlor	2 / 31	6.45	
Inorganics (µg/l)			
Aluminum	22 / 42	52.4	
Antimony	2 / 42	4.76	X
Arsenic	26 / 42	61.9	
Barium	42 / 42	100	
Calcium	42 / 42	100	
Chromium	8 / 42	19.0	
Cobalt	7 / 42	16.7	
Copper	3 / 42	7.14	
Iron	42 / 42	100	
Lead	13 / 42	31.0	
Magnesium	42 / 42	100	
Manganese	41 / 42	97.6	
Mercury	3 / 42	7.14	
Nickel	20 / 42	47.6	
Potassium	42 / 42	100	
Selenium	7 / 42	16.7	
Silver	3 / 42	7.14	
Sodium	42 / 42	100	
Thallium	1 / 42	2.38	X
Vanadium	9 / 42	21.4	
Zinc	15 / 42	35.7	
September 1993			
Volatile Organics (µg/l)			
Benzene	2 / 39	5.13	
Carbon Disulfide	2 / 39	5.13	
Chlorobenzene	1 / 39	2.56	X
Chloromethane	1 / 39	2.56	X
1,1-Dichloroethane	2 / 39	5.13	
1,2-Dichloroethene(total)	1 / 39	2.56	X

TABLE 7-7 (Continued). WHOLE SITE FREQUENCY FOR SURFACE WATER

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Methylene Chloride	1 / 39	2.56	X
Tetrachloroethene	2 / 39	5.13	
Toluene	3 / 39	7.69	
1,1,1-Trichloroethane	5 / 39	12.8	
Trichloroethene	1 / 39	2.56	X
Xylenes (total)	1 / 39	2.56	X
Semivolatile Organics (μg/l)			
Chrysene	1 / 37	2.70	X
1,4-Dichlorobenzene	1 / 39	2.56	X
Fluoranthene	1 / 39	2.56	X
Phenanthrene	1 / 39	2.56	X
Pyrene	2 / 37	5.41	
Pesticides and PCBs (μg/l)			
alpha-BHC	2 / 37	5.41	
delta-BHC	1 / 37	2.70	X
alpha-Chlordane	2 / 37	5.41	
gamma-Chlordane	1 / 37	2.70	X
4,4'-DDD	2 / 37	5.41	
4,4'-DDT	2 / 37	5.41	
Endosulfan II	1 / 37	2.70	X
Endrin Aldehyde	2 / 37	5.41	
Aroclor-1248	1 / 36	2.78	X
Aroclor-1260	1 / 36	2.78	X
Inorganics (μg/l)			
Aluminum	24 / 39	61.5	
Antimony	2 / 39	5.13	
Arsenic	15 / 39	38.5	
Barium	38 / 39	97.4	
Beryllium	2 / 39	5.13	
Cadmium	1 / 39	2.56	X
Calcium	39 / 39	100	
Chromium	9 / 39	23.1	
Cobalt	7 / 39	17.9	
Copper	4 / 39	10.3	

TABLE 7-7 (Continued). WHOLE SITE FREQUENCY FOR SURFACE WATER

Analyte	Whole Site Frequency	%	X (if <5%)(1)
Iron	39 / 39	100	
Lead	12 / 39	30.8	
Magnesium	39 / 39	100	
Manganese	39 / 39	100	
Nickel	4 / 39	10.3	
Potassium	39 / 39	100	
Selenium	2 / 39	5.13	
Silver	3 / 39	7.69	
Sodium	39 / 39	100	
Thallium	3 / 39	7.69	
Vanadium	9 / 39	23.1	
Zinc	9 / 39	23.1	

NOTES:

1. Those chemicals detected below 5% for the whole site were eliminated as COPC.

TABLE 7-8. COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE SOIL AT IRON HORSE PARK

Chemical	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
B&M Railroad Landfill					
Volatile Organics (µg/kg)					
Acetone	42	NAP	NAP	10,000 (1)	N
2-Butanone	7	NAP	NAP	10,000 (1)	N
Methylene Chloride	280	36	Y	NA	---
Semivolatile Organics (µg/kg)					
Acenaphthene	340	NAP	NAP	NA	---
Acenaphthylene	3,200	NAP	NAP	NA	---
Anthracene	5,800	NAP	NAP	10,000 (11)	N
Benzo(a)anthracene	16,000	NAP	NAP	1,000 (4)	Y
Benzo(a)pyrene	18,000	NAP	NAP	5 (5)	Y
Benzo(b)fluoranthene	33,000	NAP	NAP	19,000 (6)	Y
Benzo(g,h,i)perylene	10,000	NAP	NAP	1,000 (1)	Y
bis(2-Chloroethyl) ether	280	NAP	NAP	NA	---
Bis(2-ethylhexyl)phthalate	25,000	NAP	NAP	70,000 (5)	N
Butylbenzylphthalate	10,000	NAP	NAP	NA	---
Carbazole	3,400	NAP	NAP	NA	---
Chrysene	20,000	NAP	NAP	5,000 (4)	Y
Di-n-butylphthalate	390	NAP	NAP	60 (1)	Y
Dibenzo(a,h)anthracene	4,200	NAP	NAP	1,000 (4)	Y
Dibenzofuran	290	NAP	NAP	NA	---
Fluoranthene	28,000	NAP	NAP	10,000 (11)	Y
Fluorene	340	NAP	NAP	30,000 (12)	N
Indeno(1,2,3-cd)pyrene	10,000	NAP	NAP	1,000 (1)	Y
Isophorone	430	NAP	NAP	NA	---
2-Methylnaphthalene	260	NAP	NAP	NA	---
4-Methylphenol	96	NAP	NAP	NA	---
Naphthalene	280	NAP	NAP	5,000 (11)	N
Phenanthrene	17,000	NAP	NAP	5,000 (11)	Y
Phenol	200	NAP	NAP	30,000 (12)	N
Pyrene	24,000	NAP	NAP	10,000 (11)	Y

TABLE 7-8 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE SOIL AT IRON HORSE PARK

Chemical	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Pesticides and PCBs (µg/kg)					
Aldrin	3.9	NAP	NAP	NA	---
alpha-BHC	2.5	NAP	NAP	100 2,3	N
beta-BHC	1.1	NAP	NAP	100 2,3	N
delta-BHC	1.4	NAP	NAP	100 2,3	N
gamma-BHC(Lindane)	1.8	NAP	NAP	100 (2)	N
alpha-Chlordane	13	0.27	Y	500 (1)	N
gamma-Chlordane	7.5	NAP	NAP	500 (1)	N
4,4'-DDD	97	2.6	Y	100 2,7	N
4,4'-DDE	50	4.9	Y	100 2,7	N
4,4'-DDT	230	7.7	Y	100 (2)	Y
Dieldrin	5.2	2.1	Y	10 (8)	N
Endosulfan I	1.9	NAP	NAP	100 (9)	N
Endosulfan II	23	1.0	Y	100 (9)	N
Endosulfan Sulfate	79	NAP	NAP	100 (9)	N
Endrin	140	NAP	NAP	NA	---
Endrin Aldehyde	110	NAP	NAP	NA	---
Endrin Ketone	170	NAP	NAP	NA	---
Heptachlor	0.59	NAP	NAP	50 (2)	N
Heptachlor Epoxide	9.7	2.0	Y	50 2,10	N
Methoxychlor	170	1.8	Y	NA	---
Inorganics (mg/kg)					
Aluminum	7,260	9,630	N	NA	---
Antimony	155	NAP	NAP	4.5 (2)	Y
Arsenic	36.0	7.60	Y	60 (12)	N
Barium	922	32.0	Y	400 (13)	Y
Cadmium	34.8	NAP	NAP	20 (2)	Y
Calcium	14,700	949	Y	NA	---
Chromium	304	NAP	NAP	0.4 (12)	Y
Cobalt	26.0	NAP	NAP	50 (11)	N
Copper	1,030	8.90	Y	50 (12)	Y
Cyanide	39.0	NAP	NAP	NA	---

TABLE 7-8 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE SOIL AT IRON HORSE PARK

Chemical	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Iron	76,800	8,350	Y	NA	---
Lead	1,130	102	Y	500 (12)	Y
Magnesium	4,300	1,480	Y	NA	---
Manganese	1,080	206	Y	1,500 (2)	N
Mercury	3.40	NAP	NAP	0.1 (12)	Y
Nickel	154	NAP	NAP	200 (12)	N
Potassium	792	NAP	NAP	NA	---
Selenium	3.10	NAP	NAP	70 (12)	N
Silver	1.20	NAP	NAP	10 (4)	N
Vanadium	34.8	13.7	Y	150 (2)	N
Zinc	4,400	46.6	Y	200 (12)	Y
RSI Landfill					
Volatile Organics (µg/kg)					
Methylene Chloride	64	36	Y	NA	---
Semivolatile Organics (µg/kg)					
Benzo(a)anthracene	120	NAP	NAP	1,000 (4)	N
Benzo(b)fluoranthene	380	NAP	NAP	19,000 (6)	N
Chrysene	340	NAP	NAP	5,000 (4)	N
Fluoranthene	390	NAP	NAP	10,000 (11)	N
Phenol	220	NAP	NAP	30,000 (12)	N
Pyrene	330	NAP	NAP	10,000 (11)	N
Pesticides and PCBs (µg/kg)					
gamma-Chlordane	0.33	NAP	NAP	500 (1)	N
4,4'-DDD	1.6	2.6	N	100 2,7	N
4,4'-DDE	1.4	4.9	N	100 2,7	N
4,4'-DDT	5.2	7.7	N	100 (2)	N
Endosulfan II	0.51	1.0	N	100 (9)	N
Endrin	1.4	NAP	NAP	NA	--
Endrin Ketone	0.87	NAP	NAP	NA	--
Heptachlor Epoxide	0.75	2.0	N	50 2,10	N
Methoxychlor	4.0	1.8	Y	NA	--

TABLE 7-8 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE SOIL AT IRON HORSE PARK

Chemical	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Inorganics (mg/kg)					
Aluminum	9,470	9,630	N	NA	---
Arsenic	4.80	7.60	N	60 (12)	N
Barium	46.0	32.0	Y	400 (13)	N
Calcium	1,180	949	Y	NA	---
Chromium	23.7	NAP	NAP	0.4 (12)	Y
Cobalt	6.50	NAP	NAP	50 (11)	N
Copper	19.7	8.90	Y	50 (12)	N
Iron	13,600	8,350	Y	NA	---
Lead	248	102	Y	500 (12)	N
Magnesium	3,780	1,480	Y	NA	---
Manganese	212	206	Y	1,500 (2)	N
Potassium	1,990	NAP	NAP	NA	---
Vanadium	20.2	13.7	Y	150 (2)	N
Zinc	59.0	46.6	Y	200 (12)	N
B&M Locomotive Shop Disposal Areas		2.60			
Volatile Organics (µg/kg)					
Methylene Chloride	21	36	N	NA	---
Semivolatile Organics (µg/kg)					
Acenaphthene	790	NAP	NAP	NA	---
Acenaphthylene	20	NAP	NAP	NA	---
Anthracene	1,500	NAP	NAP	10,000 (11)	N
Benzo(a)anthracene	2,300	NAP	NAP	1,000 (4)	Y
Benzo(a)pyrene	1,700	NAP	NAP	5 (5)	Y
Benzo(b)fluoranthene	2,900	NAP	NAP	19,000 (6)	N
Benzo(g,h,i)perylene	960	NAP	NAP	1,000 (1)	N
Benzo(k)fluoranthene	110	NAP	NAP	19,000 (6)	N
Bis(2-ethylhexyl)phthalate	120	NAP	NAP	70,000 (5)	N
Carbazole	880	NAP	NAP	NA	---
Chrysene	2,400	NAP	NAP	5,000 (4)	N
Dibenzo(a,h)anthracene	400	NAP	NAP	1,000 (4)	N
Dibenzofuran	740	NAP	NAP	NA	---

TABLE 7-8 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE SOIL AT IRON HORSE PARK

Chemical	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Fluoranthene	4,200	NAP	NAP	10,000 (11)	N
Fluorene	760	NAP	NAP	30,000 (12)	N
Indeno(1,2,3-cd)pyrene	920	NAP	NAP	1,000 (1)	N
2-Methylnaphthalene	370	NAP	NAP	NA	---
Naphthalene	290	NAP	NAP	5,000 (11)	N
Phenanthrene	5,900	NAP	NAP	5,000 (11)	Y
Pyrene	4,800	NAP	NAP	10,000 (11)	N
Pesticides and PCBs (μg/kg)					
Aldrin	2.8	NAP	NAP	NA	---
beta-BHC	0.96	NAP	NAP	100 2,3	N
alpha-Chlordane	1.0	0.27	Y	500 (1)	N
gamma-Chlordane	4.0	NAP	NAP	500 (1)	N
4,4'-DDD	5.0	2.6	Y	100 2,7	N
4,4'-DDE	2.4	4.9	N	100 2,7	N
4,4'-DDT	9.3	7.7	Y	100 (2)	N
Dieldrin	1.7	2.1	N	10 (8)	N
Endosulfan II	2.0	1.0	Y	100 (9)	N
Endrin	3.5	NAP	NAP	NA	---
Endrin Ketone	5.6	NAP	NAP	NA	---
Heptachlor Epoxide	1.8	2.0	N	50 2,10	N
Methoxychlor	19	1.8	Y	NA	---
Aroclor-1016	2.2	NAP	NAP	NA	---
Inorganics (mg/kg)					
Aluminum	7,660	9,630	N	NA	---
Antimony	53.0	NAP	NAP	4.5 (2)	Y
Arsenic	49.3	7.60	Y	60 (12)	N
Barium	342	32.0	Y	400 (13)	N
Beryllium	0.850	NAP	NAP	1 (13)	N
Cadmium	1.0	NAP	NAP	20 (2)	N
Calcium	6,090	949	Y	NA	---
Chromium	87.4	NAP	NAP	0.4 (12)	Y
Cobalt	13.9	NAP	NAP	50 (11)	N

TABLE 7-8 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE SOIL AT IRON HORSE PARK

Chemical	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Copper	3,135	8.90	Y	50 (12)	Y
Cyanide	0.935	NAP	NAP	50 (11)	N
Iron	101,350	8,350	Y	NA	---
Lead	2,370	102	Y	500 (12)	Y
Magnesium	4,225	1,480	Y	NA	---
Manganese	917	206	Y	1,500 (2)	N
Mercury	0.190	NAP	NAP	0.1 (12)	Y
Nickel	46.5	NAP	NAP	200 (12)	N
Potassium	1,660	NAP	NAP	NA	--
Selenium	5.50	NAP	NAP	70 (12)	N
Sodium	13,000	NAP	NAP	NA	--
Thallium	0.570	NAP	NAP	NA	--
Vanadium	17.9	13.7	Y	150 (2)	N
Zinc	821	46.6	Y	200 (12)	Y

NOTES:

NAP = Not applicable.

NA = Not available.

1. Fitchko (1989).
2. Maximum allowable soil concentration in the former Soviet Union (as cited in Beyer 1990).
3. Value for gamma-BHC(Lindane) conservatively used.
4. Indicative of moderate soil contamination as designated by the soil cleanup criteria of Quebec (as cited in Beyer 1990).
5. Acceptable concentration proposed by Ontario Ministry of Environment (as cited in Beyer 1990).
6. Kappleman (1993).
7. For Screening purposes, maximum allowable DDT concentration was used for DDE and DDT.
8. Decreased cocoon production by *Eisenia fetida* (Reinecke and Venter 1985 as cited in Beyer 1990).
9. Tenative allowable concentration for endosulfan in the former Soviet Union (as cited in Beyer 1990).
10. Value for heptachlor.
11. Soil criteria for evaluating the severity of contamination under the Dutch Soil Cleanup (Interim) Act (as cited in Beyer 1990).
12. Will and Suter (1994).
13. Guidelines for the New Jersey Environmental Cleanup Responsibility Act (as cited in Beyer 1990).

TABLE 7-9. COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
West Middlesex Canal Group					
Volatile Organics (µg/kg)					
2-Butanone	22	120	N	NA	---
Toluene	18	NAP	NAP	786 (3)	N
Xylenes (total)	120	NAP	NAP	323 (3)	N
Semivolatile Organics (µg/kg)					
Benzo(a)anthracene	2,600	42	Y	320 (1)	Y
Benzo(a)pyrene	70	290	N	370 (1)	N
Benzo(b)fluoranthene	3,600	110	Y	240 (1,10)	Y
Benzo(k)fluoranthene	3,000	NAP	NAP	240 (1)	Y
Bis(2-ethylhexyl)phthalate	7,400	140	Y	13,000,000 (3)	N
Butylbenzylphthalate	350	NAP	NAP	49 (4)	Y
Chrysene	3,600	58	Y	340 (1)	Y
Fluoranthene	5,400	85	Y	750 (1)	Y
2-Methylnaphthalene	1,500	NAP	NAP	70 (2)	Y
Phenanthrene	2,000	65	Y	560 (1)	Y
Pyrene	620	130	Y	490 (1)	Y
Pesticides and PCBs (µg/kg)					
alpha-BHC	0.46	NAP	NAP	6 (1)	N
delta-BHC	0.32	0.24	Y	3 (1,9)	N
alpha-Chlordane	18	1.6	Y	7 (1,5)	Y
gamma-Chlordane	18	1.8	Y	7 (1,5)	Y
4,4'-DDD	34	12	Y	8 (1)	Y
4,4'-DDE	18	10	Y	5 (1)	Y
Dieldrin	10	0.87	Y	2 (1)	Y
Endosulfan I	2.0	1.1	Y	NA	---
Endosulfan II	2.0	NAP	NAP	NA	---
Endrin	5.3	NAP	NAP	3 (1)	Y
Heptachlor Epoxide	3.1	NAP	NAP	5 (1)	N
Methoxychlor	7.6	NAP	NAP	NA	---
Aroclor-1016	4.4	9.6	N	7 (1)	N
Aroclor-1242	13	NAP	NAP	6,280 (3)	N

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Aroclor-1248	2,000	36	Y	30 (1)	Y
Aroclor-1254	24	NAP	NAP	60 (1)	N
Inorganics (mg/kg)					
Aluminum	29,400	14,800	Y	NA	---
Arsenic	101	5.20	Y	6 (1)	Y
Barium	111	59.1	Y	NA	---
Beryllium	3.80	2.70	Y	NA	---
Cadmium	5.40	NAP	NAP	0.6 (1)	Y
Calcium	215,000	6,070	Y	NA	---
Chromium	100	16.4	Y	26 (1)	Y
Cobalt	48.6	6.20	Y	NA	---
Copper	215	20.6	Y	16 (1)	Y
Iron	33,550	6,590	Y	20,000 (1)	Y
Lead	554	43.0	Y	31 (1)	Y
Magnesium	5,440	1,760	Y	NA	---
Manganese	2,745	469	Y	460 (1)	Y
Mercury	0.480	0.290	Y	0.2 (1)	Y
Nickel	132	NAP	NAP	16 (1)	Y
Potassium	1,780	1,040	Y	NA	--
Selenium	7.20	NAP	NAP	NA	---
Sodium	1,670	NAP	NAP	NA	---
Vanadium	110	14.4	Y	NA	---
Zinc	504	46.4	Y	120 (1)	Y
<u>Wetland 2 Group</u>					
Volatile Organics (µg/kg)					
Acetone	52	NAP	NAP	64 (3)	N
2-Butanone	300	120	Y	NA	---
Chlorobenzene	9.0	NAP	NAP	714 (3)	N
Semivolatile Organics (µg/kg)					
Acenaphthene	2,600	NAP	NAP	16 (2)	Y
Acenaphthylene	2,200	NAP	NAP	270 (4)	Y
Anthracene	5,200	NAP	NAP	220 (1)	Y

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Benzo(a)anthracene	40,000	42	Y	320 (1)	Y
Benzo(a)pyrene	18,000	290	Y	370 (1)	Y
Benzo(b)fluoranthene	60,000	110	Y	240 (1,10)	Y
Benzo(g,h,i)perylene	740	48	Y	170 (1)	Y
Benzo(k)fluoranthene	2,500	NAP	NAP	240 (1)	Y
Bis(2-ethylhexyl)phthalate	17,000	140	Y	13,000,000 (3)	N
Butylbenzylphthalate	1,800	NAP	NAP	49 (4)	Y
Carbazole	2,300	NAP	NAP	NA	---
bis(2-Chloroethyl) ether	550	NAP	NAP	NA	---
Chrysene	25,000	58	Y	340 (1)	Y
Dibenzo(a,h)anthracene	140	NAP	NAP	60 (1)	Y
Dibenzofuran	1,600	NAP	NAP	2,290 (3)	N
1,2-Dichlorobenzene	750	NAP	NAP	23 (4)	Y
1,4-Dichlorobenzene	230	NAP	NAP	31 (4)	Y
Fluoranthene	48,000	85	Y	750 (1)	Y
Fluorene	3,300	NAP	NAP	190 (1)	Y
Indeno(1,2,3-cd)pyrene	18,000	40	Y	200 (1)	Y
2-Methylnaphthalene	1,500	NAP	NAP	70 (2)	Y
4-Methylphenol	2,900	NAP	NAP	NA	---
Naphthalene	2,300	NAP	NAP	160 (2)	Y
N-Nitrosodiphenylamine	300	NAP	NAP	110 (4)	Y
Phenanthrene	36,000	65	Y	560 (1)	Y
Pyrene	62,000	130	Y	490 (1)	Y
Pesticides and PCBs (µg/kg)					
Aldrin	0.16	NAP	NAP	2 (1)	N
alpha-BHC	0.25	NAP	NAP	6 (1)	N
beta-BHC	0.19	0.48	N	5 (1)	N
delta-BHC	3.3	0.24	Y	3 (1,9)	Y
gamma-BHC(Lindane)	8.3	NAP	NAP	3 (1)	Y
alpha-Chlordane	3.4	1.6	Y	7 (1,5)	N
gamma-Chlordane	1.7	1.8	N	7 (1,5)	N
4,4'-DDD	83	12	Y	8 (1)	Y

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
4,4'-DDE	47	10	Y	5 (1)	Y
Dieldrin	17	0.87	Y	2 (1)	Y
Endosulfan II	8.0	NAP	NAP	NA	---
Endosulfan Sulfate	1.5	NAP	NAP	NA	---
Endrin	15	NAP	NAP	3 (1)	Y
Endrin Aldehyde	190	NAP	NAP	3 (1,8)	Y
Endrin Ketone	3.7	NAP	NAP	3 (1,8)	Y
Heptachlor Epoxide	0.93	NAP	NAP	5 (1)	N
Methoxychlor	26	NAP	NAP	NA	---
Aroclor-1232	3.8	NAP	NAP	56,540 (3)	N
Aroclor-1242	43	NAP	NAP	6,280 (3)	N
Aroclor-1248	570	36	Y	30 (1)	Y
Aroclor-1254	320	NAP	NAP	60 (1)	Y
Inorganics (mg/kg)					
Aluminum	30,200	14,800	Y	NA	---
Antimony	158	NAP	NAP	2 (11)	Y
Arsenic	40.8	5.20	Y	6 (1)	Y
Barium	197	59.1	Y	NA	---
Beryllium	3.70	2.70	Y	NA	---
Cadmium	3.40	NAP	NAP	0.6 (1)	Y
Calcium	11,100	6,070	Y	NA	---
Chromium	106	16.4	Y	26 (1)	Y
Cobalt	24.7	6.20	Y	NA	---
Copper	3,600	20.6	Y	16 (1)	Y
Cyanide	1.20	NAP	NAP	NA	---
Iron	50,200	6,590	Y	20,000 (1)	Y
Lead	2,970	43.0	Y	31 (1)	Y
Magnesium	7,400	1,760	Y	NA	---
Manganese	1,230	469	Y	460 (1)	Y
Mercury	0.950	0.290	Y	0.2 (1)	Y
Nickel	45.3	NAP	NAP	16 (1)	Y
Potassium	4,630	1,040	Y	NA	---

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Selenium	10.2	NAP	NAP	NA	---
Silver	2.90	NAP	NAP	1 (2)	Y
Sodium	1,700	NAP	NAP	NA	---
Vanadium	52.5	14.4	Y	NA	---
Zinc	998	46.4	Y	120 (1)	Y
East Middlesex Canal Group					
Volatile Organics (µg/kg)					
Acetone	120	NAP	NAP	64 (3)	Y
Bromomethane	44	NAP	NAP	NA	---
2-Butanone	35	120	N	NA	---
Chloromethane	14	NAP	NAP	NA	---
Toluene	110	NAP	NAP	786 (3)	N
1,1,1-Trichloroethane	10	NAP	NAP	878 (3)	N
Xylenes (total)	9.0	NAP	NAP	786 (3)	N
Semivolatile Organics (µg/kg)					
Benzo(a)anthracene	94	42	Y	320 (1)	N
Benzo(a)pyrene	62	290	N	370 (1)	N
Benzo(b)fluoranthene	120	110	Y	240 (1,10)	N
Benzo(k)fluoranthene	73	NAP	NAP	240 (1)	N
Bis(2-ethylhexyl)phthalate	68	140	N	13,000,000 (3)	N
Chrysene	120	58	Y	340 (1)	N
Fluoranthene	260	85	Y	750 (1)	N
4-Methylphenol	50	NAP	NAP	NA	---
Naphthalene	68	NAP	NAP	160 (2)	N
Phenanthrene	35	65	N	560 (1)	N
Pyrene	370	130	Y	490 (1)	N
Pesticides and PCBs (µg/kg)					
beta-BHC	0.33	0.48	N	5 (1)	N
delta-BHC	0.39	0.24	Y	3 (1,9)	N
alpha-Chlordane	1.3	1.6	N	7 (1,5)	N
gamma-Chlordane	0.41	1.8	N	7 (1,5)	N
4,4'-DDD	21	12	Y	8 (1)	Y

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
4,4'-DDE	7.2	10	N	5 (1)	Y
4,4'-DDT	0.31	0.64	N	8 (1,6)	N
Dieldrin	1.0	0.87	Y	2 (1)	N
Endosulfan I	1.2	1.1	Y	NA	---
Endosulfan Sulfate	0.44	NAP	NAP	NA	---
Endrin	0.16	NAP	NAP	3 (1)	N
Methoxychlor	0.42	NAP	NAP	NA	---
Aroclor-1232	150	NAP	NAP	56,540 (3)	N
Aroclor-1242	19	NAP	NAP	6,280 (3)	N
Inorganics (mg/kg)					
Aluminum	5,190	14,800	N	NA	---
Arsenic	10.1	5.20	Y	6 (1)	Y
Barium	100	59.1	Y	NA	---
Beryllium	1.70	2.70	N	NA	---
Calcium	10,300	6,070	Y	NA	---
Cobalt	10.0	6.20	Y	NA	---
Copper	17.7	20.6	N	16 (1)	Y
Iron	8,810	6,590	Y	20,000 (1)	N
Lead	310	43.0	Y	31 (1)	Y
Magnesium	1,620	1,760	N	NA	---
Manganese	2,700	469	Y	460 (1)	Y
Mercury	0.650	0.290	Y	0.2 (1)	Y
Potassium	646	1,040	N	NA	---
Selenium	2.10	NAP	NAP	NA	---
Vanadium	15.9	14.4	Y	NA	---
Zinc	60.1	46.4	Y	120 (1)	N
Richardson Pond Group					
Volatile Organics (μg/kg)					
Acetone	503	NAP	NAP	64 (3)	Y
Benzene	54	NAP	NAP	52 (3)	Y
2-Butanone	210	120	Y	NA	---
1,2-Dichloroethene(total)	70	NAP	NAP	23 (3)	Y

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
1,1,2,2-Tetrachloroethane	80	NAP	NAP	550 (3)	N
Toluene	200	NAP	NAP	786 (3)	N
Xylenes (total)	990	NAP	NAP	323 (3)	Y
Semivolatile Organics (µg/kg)					
Acenaphthene	6,550	NAP	NAP	16 (2)	Y
Anthracene	6,350	NAP	NAP	220 (1)	Y
Benzo(a)anthracene	21,000	42	Y	320 (1)	Y
Benzo(a)pyrene	15,000	290	Y	370 (1)	Y
Benzo(b)fluoranthene	19,000	110	Y	240 (1,10)	Y
Benzo(g,h,i)perylene	8,950	48	Y	170 (1)	Y
Benzo(k)fluoranthene	12,500	NAP	NAP	240 (1)	Y
Bis(2-ethylhexyl)phthalate	2,800	140	Y	13,000,000 (3)	N
Butylbenzylphthalate	910	NAP	NAP	49 (4)	Y
Chrysene	20,000	58	Y	340 (1)	Y
Dibenzo(a,h)anthracene	2,950	NAP	NAP	60 (1)	Y
Dibenzofuran	1,300	NAP	NAP	2,290 (3)	N
Fluoranthene	32,500	85	Y	750 (1)	Y
Fluorene	6,600	NAP	NAP	190 (1)	Y
Indeno(1,2,3-cd)pyrene	7,700	40	Y	200 (1)	Y
2-Methylnaphthalene	190	NAP	NAP	70 (2)	Y
4-Methylphenol	720	NAP	NAP	NA	---
Naphthalene	650	NAP	NAP	160 (2)	Y
Phenanthrene	31,500	65	Y	560 (1)	Y
Pyrene	48,000	130	Y	490 (1)	Y
Pesticides and PCBs (µg/kg)					
Aldrin	2.4	NAP	NAP	2 (1)	Y
beta-BHC	0.22	0.48	N	5 (1)	N
delta-BHC	2.3	0.24	Y	3 (1,9)	N
alpha-Chlordane	1.9	1.6	Y	7 (1,5)	N
gamma-Chlordane	2.8	1.8	Y	7 (1,5)	N
4,4'-DDD	37	12	Y	8 (1)	Y
4,4'-DDE	20	10	Y	5 (1)	Y

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
4,4'-DDT	9.6	0.64	Y	8 (1,6)	Y
Dieldrin	10	0.87	Y	2 (1)	Y
Endosulfan I	3.4	1.1	Y	NA	---
Endosulfan II	0.50	NAP	NAP	NA	---
Endosulfan Sulfate	1.8	NAP	NAP	NA	---
Endrin	14	NAP	NAP	3 (1)	Y
Endrin Ketone	2.3	NAP	NAP	3 (1,8)	N
Heptachlor Epoxide	0.74	NAP	NAP	5 (1)	N
Methoxychlor	12	NAP	NAP	NA	---
Aroclor-1232	170	NAP	NAP	56,540 (3)	N
Aroclor-1242	220	NAP	NAP	6,280 (3)	N
Aroclor-1260	260	NAP	NAP	5 (1)	Y
Inorganics (mg/kg)					
Aluminum	26,300	14,800	Y	NA	---
Arsenic	26.5	5.20	Y	6 (1)	Y
Barium	287	59.1	Y	NA	---
Beryllium	3.20	2.70	Y	NA	---
Cadmium	1.30	NAP	NAP	0.6 (1)	Y
Calcium	7,910	6,070	Y	NA	---
Chromium	64.6	16.4	Y	26 (1)	Y
Cobalt	19.9	6.20	Y	NA	---
Copper	194	20.6	Y	16 (1)	Y
Iron	49,500	6,590	Y	20,000 (1)	Y
Lead	400	43.0	Y	31 (1)	Y
Magnesium	9,700	1,760	Y	NA	---
Manganese	1,160	469	Y	460 (1)	Y
Mercury	1.30	0.290	Y	0.2 (1)	Y
Nickel	46.7	NAP	NAP	16 (1)	Y
Potassium	4,600	1,040	Y	NA	---
Selenium	1.80	NAP	NAP	NA	---
Silver	2.30	NAP	NAP	1 (2)	Y
Sodium	2,185	NAP	NAP	NA	---

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Vanadium	76.4	14.4	Y	NA	---
Zinc	669	46.4	Y	120 (1)	Y
<u>Content Brook Wetland Group</u>					
Volatile Organics (µg/kg)					
Acetone	112	NAP	NAP	64 (3)	Y
Benzene	33	NAP	NAP	52 (3)	N
2-Butanone	79	120	N	NA	---
Chlorobenzene	39	NAP	NAP	714 (3)	N
Ethylbenzene	440	NAP	NAP	3,300 (3)	N
Methylene Chloride	18	NAP	NAP	427 (3)	N
1,1,2,2-Tetrachloroethane	80	NAP	NAP	550 (3)	N
Toluene	41	NAP	NAP	786 (3)	N
Xylenes (total)	410	NAP	NAP	323 (3)	Y
Semivolatile Organics (µg/kg)					
Acenaphthene	160	NAP	NAP	16 (2)	Y
Acenaphthylene	180	NAP	NAP	270 (4)	N
Anthracene	370	NAP	NAP	220 (1)	Y
Benzo(a)anthracene	1,300	42	Y	320 (1)	Y
Benzo(a)pyrene	1,100	290	Y	370 (1)	Y
Benzo(b)fluoranthene	1,400	110	Y	240 (1,10)	Y
Benzo(g,h,i)perylene	470	48	Y	170 (1)	Y
Benzo(k)fluoranthene	1,300	NAP	NAP	240 (1)	Y
Bis(2-ethylhexyl)phthalate	240	140	Y	13,000,000 (3)	N
Carbazole	270	NAP	NAP	NA	---
Chrysene	1,500	58	Y	340 (1)	Y
Dibenzo(a,h)anthracene	310	NAP	NAP	60 (1)	Y
Dibenzofuran	290	NAP	NAP	2,290 (3)	N
Fluoranthene	3,300	85	Y	750 (1)	Y
Fluorene	770	NAP	NAP	190 (1)	Y
Indeno(1,2,3-cd)pyrene	590	40	Y	200 (1)	Y
2-Methylnaphthalene	130	NAP	NAP	70 (2)	Y
Naphthalene	450	NAP	NAP	160 (2)	Y

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Phenanthrene	2,700	65	Y	560 (1)	Y
Pyrene	3,100	130	Y	490 (1)	Y
Pesticides and PCBs (μg/kg)					
Aldrin	0.31	NAP	NAP	2 (1)	N
delta-BHC	0.16	0.24	N	3 (1,9)	N
alpha-Chlordane	0.43	1.6	N	7 (1,5)	N
gamma-Chlordane	0.87	1.8	N	7 (1,5)	N
4,4'-DDD	16	12	Y	8 (1)	Y
4,4'-DDE	6.4	10	N	5 (1)	Y
Dieldrin	2.7	0.87	Y	2 (1)	Y
Endosulfan I	0.39	1.1	N	NA	---
Endosulfan II	9.4	NAP	NAP	NA	---
Endosulfan Sulfate	0.30	NAP	NAP	NA	---
Endrin	0.42	NAP	NAP	3 (1)	N
Endrin Ketone	0.79	NAP	NAP	3 (1,8)	N
Heptachlor	0.54	NAP	NAP	0.3 (1,7)	Y
Heptachlor Epoxide	0.33	NAP	NAP	5 (1)	N
Methoxychlor	14	NAP	NAP	NA	---
Aroclor-1254	20	NAP	NAP	60 (1)	N
Aroclor-1260	340	NAP	NAP	5 (1)	Y
Inorganics (mg/kg)					
Aluminum	32,300	14,800	Y	NA	---
Arsenic	256	5.20	Y	6 (1)	Y
Barium	253	59.1	Y	NA	---
Beryllium	1.40	2.70	N	NA	---
Calcium	13,800	6,070	Y	NA	---
Chromium	56.5	16.4	Y	26 (1)	Y
Cobalt	17.7	6.20	Y	NA	---
Copper	49.3	20.6	Y	16 (1)	Y
Iron	76,300	6,590	Y	20,000 (1)	Y
Lead	101	43.0	Y	31 (1)	Y
Magnesium	10,500	1,760	Y	NA	---

TABLE 7-9 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SEDIMENT AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Sceening Value	Exceeds Screening Value (Y/N)
Manganese	2,080	469	Y	460 (1)	Y
Mercury	0.250	0.290	N	0.2 (1)	Y
Nickel	39.2	NAP	NAP	16 (1)	Y
Potassium	7,400	1,040	Y	NA	---
Selenium	2.50	NAP	NAP	NA	---
Silver	6.70	NAP	NAP	1 (2)	Y
Sodium	1,810	NAP	NAP	NA	---
Vanadium	73.4	14.4	Y	NA	---
Zinc	115	46.4	Y	120 (1)	N

NOTES:
1. OMEE (1993).
2. Long et al. (1995).
3. Hull & Suter (1994).
4. Barrick & Beller (1989).
5. LEL for chlordane.
6. Value for op+pp DDT.
7. No effect level.
8. Value for endrin conservatively used.
9. Value for lindane conservatively used.
10. Value for benzo(k)fluoranthene.
11. NOAA (1991).

NA = Screening value not available.
NAP = Not applicable.

TABLE 7-10. COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
<u>West Middlesex Canal Group</u>					
Pesticides and PCBs (ug/l) - June 1993					
Aldrin	0.00064	NAP	NAP	NA	---
gamma-BHC(Lindane)	0.0010	NAP	N	0.08 (2)	N
alpha-Chlordane	0.00098	0.00075	Y	0.0043 (2,3)	N
Dieldrin	0.0022	NAP	NAP	0.062 (10)	N
Endrin	0.0051	NAP	NAP	0.061 (10)	N
Heptachlor Epoxide	0.0019	NAP	NAP	0.0038 (2)	N
Methoxychlor	0.0029	NAP	NAP	0.019 (10)	N
Pesticides and PCBs (ug/l) - September 1993					
delta-BHC	0.016	NAP	NAP	2.44 (1)	N
Aroclor-1248	0.17	NAP	NAP	0.014 (2)	Y
Inorganics (ug/l) - June 1993					
Aluminum	1,610	6,290	N	87 (2,7)	Y
Arsenic	22.1	18.1	Y	190 (8)	N
Barium	55.7	155	N	3.8 (1)	Y
Calcium	14,600	24,800	N	NA	---
Chromium	7.10	9.90	N	11 (2,9)	N
Iron	12,450	27,000	N	1,000 (2)	Y
Lead	21.9	40.9	N	HD	---
Magnesium	3,040	4,930	N	NA	---
Manganese	1,160	5,840	N	80.3 (1)	Y
Nickel	6.70	18.6	N	HD	---
Potassium	12,000	3,530	Y	NA	---
Sodium	31,600	37,200	N	NA	---
Zinc	49.3	158	N	HD	---
Inorganics (ug/l) - September 1993					
Aluminum	1,730	18,500	N	87 (2,7)	Y
Arsenic	43.3	39.8	Y	190 (8)	N

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Barium	99.8	285	N	3.8 (1)	Y
Calcium	14,050	27,900	N	NA	---
Chromium	4.80	25.9	N	11 (2,9)	N
Iron	15,500	71,200	N	1,000 (2)	Y
Lead	27.8	122	N	HD	---
Magnesium	2,495	6,570	N	NA	---
Manganese	3,530	6,740	N	80.3 (1)	Y
Potassium	3,590	4,500	N	NA	---
Sodium	31,300	23,000	Y	NA	---
Thallium	2.05	2.90	N	18 (1)	N
Vanadium	4.50	49.1	N	19.1 (1)	N
Zinc	109	505	N	HD	---
Wetland 2 Group					
Volatile Organics (ug/l) - June 1993					
1,2-Dichloroethene(total)	11	NAP	NAP	31.2 (1)	N
Tetrachloroethene	16	NAP	NAP	120 (10)	N
1,1,1-Trichloroethane	20	NAP	NAP	62.1 (1)	N
Trichloroethene	8.0	NAP	NAP	350 (10)	N
Volatile Organics (ug/l) - September 1993					
Carbon Disulfide	5.0	NAP	NAP	8.9 (1)	N
Chlorobenzene	2.0	NAP	NAP	127 (1)	N
1,1-Dichloroethane	11	NAP	NAP	46.6 (1)	N
1,2-Dichloroethene(total)	12	NAP	NAP	31.2 (1)	N
Methylene Chloride	10	NAP	NAP	2,240 (1)	N
Tetrachloroethene	12	NAP	NAP	120 (10)	N
1,1,1-Trichloroethane	17	NAP	NAP	62.1 (1)	N
Trichloroethene	8.5	NAP	NAP	350 (10)	N
Semivolatile Organics (ug/l) - June 1993					
Acenaphthene	0.50	NAP	NAP	23 (10)	N
Benzo(b)fluoranthene	1.0	0.70	Y	NA	---
Bis(2-ethylhexyl)phthalate	1.0	0.80	Y	32.2 (1)	N

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Fluoranthene	0.70	0.60	Y	6.16 (1)	N
Phenanthrene	0.80	0.60	Y	6.3 (10)	N
Pyrene	1.0	0.90	Y	NA	---
Semivolatile Organics (ug/l) - September 1993					
Pyrene		1.0	N	NA	---
Pesticides and PCBs (ug/l) - June 1993					
Aldrin	0.00069	NAP	NAP	NA	---
alpha-BHC	0.0020	NAP	NAP	2.44 (1)	N
gamma-BHC(Lindane)	0.0074	NAP	NAP	0.08 (2)	N
alpha-Chlordane	0.0012	0.00075	Y	0.0043 (2,3)	N
4,4'-DDD	0.0053	NAP	NAP	0.01 (1)	N
4,4'-DDT	0.0020	NAP	NAP	0.013 (10)	N
Endosulfan II	0.0011	0.0011	N	0.056 (2)	N
Endrin	0.021	NAP	NAP	0.061 (10)	N
Endrin Aldehyde	0.0050	NAP	NAP	0.061 (4,10)	N
Pesticides and PCBs (ug/l) - September 1993					
Endrin Aldehyde	0.0050	0.0060	N	0.061 (4,10)	N
Inorganics (ug/l) - June 1993					
Aluminum	2,460	6,290	N	87 (2,7)	Y
Arsenic	71.0	18.1	Y	190 (8)	N
Barium	156	155	Y	3.8 (1)	Y
Calcium	31,800	24,800	Y	NA	---
Chromium	11.5	9.90	Y	11 (2,9)	Y
Cobalt	22.5	33.2	N	3.06 (1)	Y
Copper	29.8	NAP	NAP	HD	---
Iron	53,300	27,000	Y	1,000 (2)	Y
Lead	59.1	40.9	Y	HD	---
Magnesium	5,530	4,930	Y	NA	---
Manganese	4,810	5,840	N	80.3 (1)	Y
Mercury	0.180	NAP	NAP	0.012 (2)	Y
Nickel	9.40	18.6	N	HD	---

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Potassium	4,410	3,530	Y	NA	---
Selenium	3.60	NAP	NAP	5 (2)	N
Sodium	205,000	37,200	Y	NA	---
Vanadium	8.50	19.0	N	19.1 (1)	N
Zinc	165	158	Y	HD	---
Inorganics (ug/l) - September 1993					
Aluminum	6,200	18,500	N	87 (2,7)	Y
Arsenic	155	39.8	Y	190 (8)	N
Barium	842	285	Y	3.8 (1)	Y
Cadmium	28.2	NAP	NAP	HD	---
Calcium	56,300	27,900	Y	NA	---
Chromium	36.9	25.9	Y	11 (2,9)	Y
Cobalt	27.7	72.5	N	3.06 (1)	Y
Copper	636	7.80	Y	HD	---
Iron	90,500	71,200	Y	1,000 (2)	Y
Lead	630	122	Y	HD	---
Magnesium	11,700	6,570	Y	NA	---
Manganese	1,680	6,740	N	80.3 (1)	Y
Nickel	324	48.2	Y	HD	---
Potassium	7,570	4,500	Y	NA	---
Silver	6.50	NAP	NAP	0.36 (1)	Y
Sodium	153,500	23,000	Y	NA	---
Thallium	2.90	2.90	N	18 (1)	N
Vanadium	38.9	49.1	N	19.1 (1)	Y
Zinc	5,100	505	Y	HD	---
East Middlesex Canal Group					
Semivolatile Organics (ug/l) - June 1993					
Bis(2-ethylhexyl)phthalate	0.70	0.80	N	32.2 (1)	N
Pesticides and PCBs (ug/l) - June 1993					
gamma-BHC(Lindane)	0.0021	NAP	NAP	0.08 (2)	N
Methoxychlor	0.025	NAP	NAP	0.019 (10)	Y

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Inorganics (ug/l) - June 1993					
Aluminum	299	6,290	N	87 (2,7)	Y
Arsenic	5.50	18.1	N	190 (8)	N
Barium	54.5	155	N	3.8 (1)	Y
Calcium	21,900	24,800	N	NA	---
Iron	2,050	27,000	N	1,000 (2)	Y
Magnesium	3,990	4,930	N	NA	---
Manganese	2,250	5,840	N	80.3 (1)	Y
Potassium	3,070	3,530	N	NA	---
Sodium	67,100	37,200	Y	NA	---
Inorganics (ug/l) - September 1993					
Aluminum	188	18,500	N	87 (2,7)	Y
Antimony	14.4	NAP	NAP	30 (6)	N
Barium	53.2	285	N	3.8 (1)	Y
Calcium	20,900	27,900	N	NA	---
Copper	3.70	7.80	N	HD	---
Iron	1,850	71,200	N	1,000 (2)	Y
Magnesium	4,090	6,570	N	NA	---
Manganese	1,380	6,740	N	80.3 (1)	Y
Potassium	3,690	4,500	N	NA	---
Sodium	70,300	23,000	Y	NA	---
Zinc	12.9	505	N	HD	---
Richardson Pond Group					
Volatile Organics (ug/l) - June 1993					
Xylenes (total)	13	NAP	NAP	86.2 (1)	N
Volatile Organics (ug/l) - September 1993					
Benzene	1.0	NAP	NAP	45.5 (1)	N
Chloromethane	3.0	NAP	NAP	NA	---
Toluene	10	NAP	NAP	176 (1)	N
Semivolatile Organics (ug/l) - June 1993					
Acenaphthene	0.90	NAP	NAP	23 (10)	N

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Fluoranthene	0.60	0.60	N	6.16 (1)	N
Naphthalene	1.0	NAP	NAP	24 (10)	N
Phenanthrene	0.60	0.60	N	6.3 (6)	N
Pyrene	1.0	0.90	Y	NA	---
Semivolatile Organics (ug/l) - September 1993					
Chrysene	1.0	NAP	NAP	NA	---
Fluoranthene	2.0	1.0	Y	6.16 (1)	N
Phenanthrene	1.0	NAP	NAP	6.3 (10)	N
Pyrene	2.0	1.0	Y	NA	---
Pesticides and PCBs (ug/l) - June 1993					
gamma-Chlordane	0.0043	NAP	NAP	0.0043 (2,3)	N
Endosulfan I	0.0014	NAP	NAP	0.056 (2)	N
Endosulfan II	0.0022	0.0011	Y	0.0561 (2)	N
Endrin	0.012	NAP	NAP	0.0610 (10)	N
Pesticides and PCBs (ug/l) - September 1993					
alpha-Chlordane	0.0043	0.0090	N	0.0043 (2,3)	N
gamma-Chlordane	0.0048	0.011	N	0.0043 (2,3)	Y
4,4'-DDD	0.025	NAP	NAP	0.01 (1)	Y
4,4'-DDT	0.0053	NAP	NAP	0.013 (10)	N
Endosulfan II	0.0045	NAP	NAP	0.056 (2)	N
Endrin Aldehyde	0.0078	0.0060	Y	0.061 (4,10)	N
Aroclor-1260	0.24	NAP	NAP	0.014 (2)	Y
Inorganics (ug/l) - June 1993					
Aluminum	2,990	6,290	N	87 (2,7)	Y
Arsenic	59.8	18.1	Y	190 (8)	N
Barium	414	155	Y	3.8 (1)	Y
Calcium	38,200	24,800	Y	NA	---
Chromium	7.0	9.90	N	11 (2,9)	N
Cobalt	6.60	33.2	N	3.06 (1)	Y
Iron	137,000	27,000	Y	1,000 (2)	Y
Lead	138	40.9	Y	HD	---

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Magnesium	11,100	4,930	Y	NA	---
Manganese	3,750	5,840	N	80.3 (1)	Y
Mercury	0.160	NAP	NAP	0.012 (2)	Y
Nickel	7.30	18.6	N	HD	---
Potassium	29,400	3,530	Y	NA	---
Silver	14.2	NAP	NAP	0.36 (1)	Y
Sodium	42,900	37,200	Y	NA	---
Vanadium	14.4	19.0	N	19.1 (1)	N
Zinc	193	158	Y	HD	---
Inorganics (ug/l) - September 1993					
Aluminum	41,700	18,500	Y	87 (2,7)	Y
Antimony	14.0	NAP	NAP	30 (6)	N
Arsenic	61.3	39.8	Y	190 (8)	N
Barium	802	285	Y	3.8 (1)	Y
Beryllium	1.60	2.80	N	5.3	N
Calcium	41,800	27,900	Y	NA	---
Chromium	92.3	25.9	Y	11 (2,9)	Y
Cobalt	25.6	72.5	N	3.06 (1)	Y
Copper	299	7.80	Y	HD	---
Iron	116,150	71,200	Y	1,000 (2)	Y
Lead	517	122	Y	HD	---
Magnesium	17,250	6,570	Y	NA	---
Manganese	1,130	6,740	N	80.3 (1)	Y
Potassium	12,000	4,500	Y	NA	---
Selenium	6.10	NAP	NAP	5 (2)	Y
Silver	9.15	NAP	NAP	0.36 (1)	Y
Sodium	40,500	23,000	Y	NA	---
Vanadium	102	49.1	Y	19.1 (1)	Y
Zinc	2,780	505	Y	HD	---

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Content Brook Wetland Group					
Volatile Organics (ug/l) - June 1993					
Ethylbenzene	42	NAP	NAP	389 (1)	N
Toluene	8.0	NAP	NAP	176 (1)	N
Xylenes (total)	120	NAP	NAP	86.2 (1)	Y
Volatile Organics (ug/l) - September 1993					
Benzene	1.0	NAP	NAP	45.5 (1)	N
Carbon Disulfide	1.0	NAP	NAP	8.9 (1)	N
Toluene	5.0	NAP	NAP	176 (1)	N
Xylenes (total)	4.0	NAP	NAP	86.2 (1)	N
Semivolatile Organics (ug/l) - June 1993					
Benzo(a)anthracene	1.0	NAP	NAP	0.27 (1)	Y
Benzo(b)fluoranthene	2.0	0.70	Y	NA	---
Chrysene	1.0	NAP	NAP	NA	---
1,4-Dichlorobenzene	2.0	NAP	NAP	15 (10)	N
2,4-Dimethylphenol	7.0	NAP	NAP	NA	---
Fluoranthene	1.0	0.60	Y	6.16 (1)	N
4-Methylphenol	440	NAP	NAP	NA	---
Naphthalene	4.0	NAP	NAP	24 (10)	N
Phenanthrene	1.0	NAP	NAP	6.3 (6)	N
Phenol	96	NAP	NAP	2,560 (5)	N
Pyrene	1.0	0.90	Y	NA	---
Semivolatile Organics (ug/l) - September 1993					
1,4-Dichlorobenzene	1.0	NAP	NAP	15 (10)	N
Pesticides and PCBs (ug/l) - June 1993					
Aldrin	0.014	NAP	NAP	NA	---
alpha-BHC	0.0015	NAP	NAP	2.44 (1)	N
gamma-BHC(Lindane)	0.066	NAP	NAP	0.08 (2)	N
gamma-Chlordane	0.0049	NAP	NAP	0.0043 (2,3)	Y
4,4'-DDD	0.0057	NAP	NAP	0.01 (1)	N
4,4'-DDT	0.0038	NAP	NAP	0.013 (10)	N

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Endrin	0.0046	NAP	NAP	0.061 (10)	N
Pesticides and PCBs (ug/l) - September 1993					
alpha-BHC	0.0060	0.0020	Y	2.44 (1)	N
alpha-Chlordane	0.0050	0.0090	N	0.0043 (2,3)	Y
4,4'-DDD	0.0040	NAP	NAP	0.01 (1)	N
4,4'-DDT	0.0070	NAP	NAP	0.013 (10)	N
Inorganics (ug/l) - June 1993					
Aluminum	65,000	6,290	Y	87 (2,7)	Y
Antimony	30.2	NAP	NAP	30 (6)	Y
Arsenic	13,000	18.1	Y	190 (8)	Y
Barium	10,300	155	Y	3.8 (1)	Y
Calcium	226,000	24,800	Y	NA	---
Chromium	133	9.90	Y	11 (2,9)	Y
Cobalt	51.6	33.2	Y	3.06 (1)	Y
Copper	120	NAP	NAP	HD	---
Iron	1,290,000	27,000	Y	1,000 (2)	Y
Lead	211	40.9	Y	HD	---
Magnesium	75,300	4,930	Y	NA	---
Manganese	13,500	5,840	Y	80.3 (1)	Y
Nickel	118	18.6	Y	HD	---
Potassium	113,000	3,530	Y	NA	---
Selenium	27.6	NAP	NAP	5 (2)	Y
Silver	54.0	NAP	NAP	0.36 (1)	Y
Sodium	333,000	37,200	Y	NA	---
Thallium	23.8	NAP	NAP	18 (1)	Y
Vanadium	211	19.0	Y	19.1 (1)	Y
Zinc	530	158	Y	HD	---
Inorganics (ug/l) - September 1993					
Aluminum	12,500	18,500	N	87 (2,7)	Y
Arsenic	676	39.8	Y	190 (8)	Y
Barium	595	285	Y	3.8 (1)	Y

TABLE 7-10 (Continued). COMPARISON OF MAXIMUM CONCENTRATIONS TO BACKGROUND AND SCREENING CONCENTRATIONS FOR SURFACE WATER AT IRON HORSE PARK

Analyte	Maximum Detected Concentration	Maximum Detected Background Concentration	Detected Concentration Exceeds Background Concentration (Y/N)	Screening Value	Exceeds Screening Value (Y/N)
Beryllium	0.400	2.80	N	NA	---
Calcium	98,800	27,900	Y	NA	---
Chromium	23.4	25.9	N	11 (2,9)	Y
Cobalt	9.30	72.5	N	3.06 (1)	Y
Copper	31.8	7.80	Y	HD	---
Iron	77,200	71,200	Y	1,000 (2)	Y
Lead	551	122	Y	HD	---
Magnesium	50,200	6,570	Y	NA	---
Manganese	2,580	6,740	N	80.3 (1)	Y
Nickel	63.6	48.2	Y	HD	---
Potassium	130,000	4,500	Y	NA	---
Sodium	444,000	23,000	Y	NA	---
Vanadium	29.3	49.1	N	19.1 (1)	Y
Zinc	116	505	N	HD	---

NOTES:
1. Suter and Mabrey (1994).
2. Chronic ambient water quality criterion (USEPA 1996c).
3. Chronic AWQC for chlordane.
4. Chronic AWQC for endrin.
5. Insufficient data to derive a criterion. Value presented is a chronic LOEL (USEPA 1996c).
6. Proposed chronic AWQC.
7. Also USEPA (1988b).
8. Chronic AWQC for arsenic III conservatively used.
9. Chronic AWQC for chromium conservatively used.
10. Ecotox threshold value (USEPA 1996b).

NA = Not available.
NAP = Not applicable
HD = Hardness dependent. See Table 7-11 for group specific criterion.

TABLE 7-11. CHRONIC AWQC FOR HARDNESS-DEPENDENT METALS (μg/L)

Chemical[2]	Group 1[1]		Group 2[1]		Group 3[1]		Group 4[1]		Group 5[1]	
	6/93	9/93	6/93	9/93	6/93	9/93	6/93	9/93	6/93	9/93
Cadmium	----	----	----	0.38	----	----	----	----	----	----
Copper	----	----	3.07	3.59	----	6.01	----	6.29	6.70	8.40
Lead	1.09	0.97	0.43	0.54	----	----	1.05	1.24	1.36	1.91
Nickel	77.2	----	41.4	48.5	----	----	75.2	----	89.8	112
Zinc	51.8	48.1	27.8	32.5	----	54.2	50.5	56.7	60.3	75.5

1. In order to be conservative, the lowest detected hardness value for each surface water group was used to calculate chronic AWQC. The hardness values used are listed below:

	June 1993 (mg/L)	Sept. 1993 (mg/L)
Group 1	43.0	39.4
Group 2	20.6	24.8
Group 3	12.2	45.3
Group 4	41.7	47.8
Group 5	51.4	67.0

2. For hardness equation see USEPA (1992d).

TABLE 7-12. SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL AT IRON HORSE PARK

Analyte	Area(1)		
	B&M Railroad Landfill	RSI Landfill	B&M Locomotive Shop Disposal Area
Volatile Organics:			
Methylene Chloride	X	X	X
Semivolatile Analysis:			
Acenaphthene	X		X
Acenaphthylene	X		X
Benzo(a)anthracene	X		X
Benzo(a)pyrene	X		X
Benzo(b)fluoranthene	X		
Benzo(g,h,i)perylene	X		
Butylbenzylphthalate	X		
Carbazole	X		
Chrysene	X		X
Dibenzo(a,h)anthracene	X		
Dibenzofuran	X		
Fluoranthene	X		
Indeno(1,2,3-cd)pyrene	X		
2-Methylnaphthalene	X		X
Phenanthrene	X		X
Pyrene	X		
Pesticides & PCB s			
Aldrin	X		X
4,4'-DDT	X		
Endrin	X	X	X
Endrin Aldehyde	X		
Endrin Ketone	X	X	X
Methoxychlor	X	X	X
Inorganics:			
Antimony	X		X
Barium	X		
Cadmium	X		
Chromium	X	X	X

TABLE 7-12. SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE SOIL AT IRON HORSE PARK

	Area(1)		
Analyte	B&M Railroad Landfill	RSI Landfill	B&M Locomotive Shop Disposal Area
Copper	X		X
Cyanide	X		
Iron	X	X	X
Lead	X		X
Mercury	X		X
Zinc	X		X

NOTES:

1. Due to limited habitat quality, the Old B&M Oil/Sludge Recycling Area and the Contaminated Soil Area were not quantitatively evaluated. As a result, no COPC, were selected for these 2 groups. Section 7.1.2 qualitatively discusses the chemicals detected in these areas.

X = Selected as a COPC.

TABLE 7-13. SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SEDIMENT AT IRON HORSE PARK

	Area				
Analyte	West Middlesex Canal Group	Wetland 2 Group	East Middlesex Canal Group	Richardson Pond Group	Content Brook Wetland Group
Volatile Organics:					
Acetone			X	X	X
Benzene				X	
2-Butanone	X	X	X	X	X
1,2-Dichloroethene (total)				X	
Xylenes (total)				X	X
Semivolatile Analysis:					
Acenaphthene		X		X	X
Acenaphthylene		X			
Anthracene		X		X	
Benzo(a)anthracene	X	X		X	X
Benzo(a)pyrene		X		X	X
Benzo(b)fluoranthene	X	X		X	X
Benzo(g,h,i)perylene		X		X	X
Benzo(k)fluoranthene	X	X		X	X
Butylbenzylphthalate	X	X		X	
Carbazole		X			X
Chrysene	X	X		X	X
Dibenzo(a,h)anthracene		X		X	X
Fluoranthene	X	X		X	X
Fluorene		X		X	X
Indeno(1,2,3-cd)pyrene		X		X	X
2-Methylnaphthalene	X			X	X
2-Methylnapthalene		X			
4-Methylphenol		X		X	
Naphthalene		X		X	X
N-Nitrosodiphenylamine		X			
Phenanthrene	X	X		X	X
Pyrene	X	X		X	X
Pesticides & PCB s					
Aldrin				X	

TABLE 7-13. SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SEDIMENT AT IRON HORSE PARK

Analyte	Area				
	West Middlesex Canal Group	Wetland 2 Group	East Middlesex Canal Group	Richardson Pond Group	Content Brook Wetland Group
delta-BHC		X			
alpha-Chlordane	X				
gamma-Chlordane	X				
4,4'-DDD	X	X	X	X	X
4,4'-DDE	X	X	X	X	X
4,4'-DDT				X	
Dieldrin	X	X		X	X
Endosulfan I	X		X	X	X
Endosulfan II	X	X		X	X
Endosulfan Sulfate		X	X	X	X
Endrin	X	X		X	
Endrin Aldehyde		X			
Endrin Ketone		X			
Heptachlor Epoxide					X
Methoxychlor	X	X	X	X	X
Aroclor-1248	X	X			
Aroclor-1254		X			
Inorganics:					
Aluminum	X	X		X	X
Antimony		X			
Arsenic	X	X	X	X	X
Barium	X	X	X	X	X
Beryllium	X	X		X	
Cadmium	X	X		X	
Chromium	X	X		X	X
Cobalt	X	X	X	X	X
Copper	X	X		X	X
Iron	X	X		X	X
Lead	X	X	X	X	X
Manganese	X	X	X	X	X

TABLE 7-13. SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SEDIMENT AT IRON HORSE PARK

Analyte	Area				
	West Middlesex Canal Group	Wetland 2 Group	East Middlesex Canal Group	Richardson Pond Group	Content Brook Wetland Group
Mercury	X	X	X	X	
Nickel	X	X		X	X
Selenium	X	X	X	X	X
Silver		X		X	X
Vanadium	X	X	X	X	
Zinc	X	X		X	

NOTES:
X = Selected as a COPC.

TABLE 7-14. SUMMARY OF CHEMICALS OF POTENTIAL CONCERN (COPC) IN SURFACE WATER AT IRON HORSE PARK

	Area									
	West Middlesex Canal Group		Wetland 2 Group		East Middlesex Canal Group		Richardson Pond Group		Content Brook Wetland Group	
Analyte	**June 1993**	**September 1993**	**June 1993**	**September 1993**	**June 1993**	**September 1993**	**June 1993**	**September 1993**	**June 1993**	**September 1993**
Volatile Organics:										
Xylenes (total)									X	
Semivolatile Analysis:										
Pyrene			X	X			X	X	X	
Pesticides & PCB s										
Aldrin	X		X						X	
alpha-Chlordane										X
gamma-Chlordane									X	
4,4'-DDD								X		
Methoxychlor					X					
Inorganics:										
Aluminum								X	X	X
Arsenic									X	X
Barium			X	X			X	X	X	X
Chromium			X	X				X	X	X
Cobalt							X		X	
Copper			X	X				X	X	X
Iron			X	X			X	X	X	X
Lead			X	X			X	X	X	X
Manganese									X	
Mercury			X				X			
Nickel				X					X	
Selenium								X	X	
Silver				X			X	X	X	
Vanadium				X				X	X	X
Zinc			X	X			X	X	X	

NOTES:
X = Selected as a COPC.

TABLE 7-15. SURFACE SOIL COPC SUMMARY

Surface Soil Grouping	COPC Groups	Number of COPC Selected
B&M Railroad Landfill	Volatiles, semivolatiles, pesticides, and inorganics	33
RSI Landfill	Volatiles, pesticides, and inorganics	6
B&M Locomotive Shop Disposal Areas	Volatiles, semivolatiles, pesticides, and inorganics	19
Old B&M Oil/Sludge Recycling Area	---	0
Contaminated Soil Area	---	0

TABLE 7-16. SEDIMENT COPC SUMMARY

Sediment Soil Grouping	COPC Groups	Number of COPC Selected
West Middlesex Canal Group	Volatiles, semivolatiles, pesticides, PCBs, and inorganics	36
Wetland 2 Group	Volatiles, semivolatiles, pesticides, PCBs, and inorganics	52
East Middlesex Canal Group	Volatiles, semivolatiles, pesticides, and inorganics	15
Richardson Pond Group	Volatiles, semivolatiles, pesticides, and inorganics.	50
Content Brook Wetland Group	Volatiles, semivolatiles, pesticides, and inorganics	39

TABLE 7-17. SURFACE WATER COPC SUMMARY

Surface Water Grouping	COPC Groups - June	COPC Groups - September	Number of COPC Selected - June	Number of COPC Selected - September
West Middlesex Canal Group	Pesticides	---	1	0
Wetland 2 Group	Semivolatiles, pesticides, and inorganics	Semivolatiles and inorganics	9	10
East Middlesex Canal Group	Pesticides	---	1	0
Richardson Pond Group	Semivolatiles and inorganics	Semivolatiles pesticides, and inorganics	8	12
Content Brook Wetland Group	Volatiles, semivolatiles, pesticides, and inorganics	Pesticides and inorganics	18	9

TABLE 7-18. POTENTIAL EXPOSURE PATHWAYS FOR ECOLOGICAL RECEPTORS AT IRON HORSE PARK

Potential Sources/Mechanisms of Release	Potential Receptors	Exposure Route	Pathway(s) Selected for Evaluation?	Comments
SURFACE SOIL				
Past dumping of wastes from production and landfill activities	Terrestrial plants	Uptake	No	Not evaluated because no direct evidence of vegetative loss or impairment has been observed at Iron Horse Park. Adverse effects on vegetation would be considered ecologically significant only if the severity of adverse effects was great enough to affect habitat value for wildlife or if the potential existed for impacts to protected plant species.
	Terrestrial invertebrates (e.g., earthworms)	Ingestion and dermal absorption	Yes	Pathway potentially complete; selected for quantitative evaluation.
	Terrestrial wildlife (e.g., small mammals)	Ingestion	Yes	Pathway potentially complete; selected for quantitative evaluation.
		Dermal absorption	No	Pathway is not likely to contribute significant risks compared to ingestion pathway.
AIR				
Wind entrainment of surface soil; volatilization of chemicals to air within burrow	Terrestrial wildlife	Inhalation	No	Many of the sampling locations at the Iron Horse Park Site are covered with vegetation. Thus, exposure to chemicals via the wind entrainment of surface soil in air is not expected to be significant. Few volatiles were detected in each surface soil group quantitatively evaluated. Thus, the potential for exposure via inhalation within burrows is limited.

TABLE 7-18 (Continued). POTENTIAL EXPOSURE PATHWAYS FOR ECOLOGICAL RECEPTORS AT IRON HORSE PARK

Potential Sources/Mechanisms of Release	Potential Receptors	Exposure Route	Pathway(s) Selected for Evaluation?	Comments
FOOD				
Food items that have accumulated chemicals	Terrestrial/Semi-aquatic wildlife (e.g., migratory birds)	Ingestion of aquatic organisms	Yes	Pathway potentially complete; selected for quantitative evaluation.
	Terrestrial wildlife (e.g., small mammals)	Ingestion of earthworms	Yes	Pathway potentially complete; selected for quantitative evaluation.
SURFACE WATER				
Surficial runoff; discharge of groundwater to surface water	Terrestrial/Semi-aquatic wildlife	Ingestion	Yes	Pathway potentially complete; selected for quantitative evaluation.
		Dermal Absorption	No	Pathway is not likely to contribute to significant risks compared to ingestion pathway.
	Aquatic life (e.g., water column receptors and fish) in Iron Horse Park surface water bodies	Ingestion, respiration, and dermal absorption	Yes	Pathway potentially complete; selected for quantitative evaluation.
	Wetland and aquatic plants in Iron Horse Park surface water bodies	Uptake	No	Not evaluated because no direct evidence of vegetative loss or impairment has been observed at Iron Horse Park. Adverse effects on vegetation would be considered ecologically significant only if the severity of adverse effects was great enough to affect habitat value for wildlife or if the potential existed for impacts to protected plant species.

TABLE 7-18 (Continued). POTENTIAL EXPOSURE PATHWAYS FOR ECOLOGICAL RECEPTORS AT IRON HORSE PARK

Potential Sources/Mechanisms of Release	Potential Receptors	Exposure Route	Pathway(s) Selected for Evaluation?	Comments
SEDIMENT				
Surficial runoff; discharge of groundwater to surface water	Terrestrial/semi-aquatic wildlife	Ingestion	Yes	Pathway potentially complete; selected for quantitative evaluation.
		Dermal absorption	No	Pathway is not likely to contribute to significant risks compared to ingestion pathway.
	Benthic-dwelling aquatic life in Iron Horse Park surface water bodies	Ingestion, respiration, and dermal absorption	Yes	Pathway potentially complete; selected for quantitative evaluation.

TABLE 7-19. ASSESSMENT AND MEASUREMENT ENDPOINTS FOR TERRESTRIAL HABITATS

Assessment Endpoint	Indicators of Effects	Measurement Endpoint
Evidence of significant reduction in soil invertebrate populations.	Surface soil contaminant concentrations exceed toxicity benchmarks for earthworms.	Comparison of average exposure Hazard Quotient (HQ) for earthworms to reference HQ of 10.
Evidence of significant reduction in small mammal populations.	Exposures exceed toxicity doses for short-tailed shrews.	Comparison of average exposure HQ for short-tailed shrews to reference HQ of 10.

TABLE 7-20. ASSESSMENT AND MEASUREMENT ENDPOINTS FOR AQUATIC HABITATS

Assessment Endpoint	Indicators of Effect	Measurement Endpoint
Evidence of significant reduction in aquatic populations.	Surface water and/or sediment contaminant concentrations exceed toxicity benchmarks for water column and benthic receptors.	Comparison of site Hazard Quotient (HQ) for water column and benthic receptors to reference HQ of 10.
Evidence of significant reduction in aquatic populations.	Impairment of the invertebrate community relative to reference locations.	Comparison of site and reference benthic data.
Evidence of significant reduction in migratory bird population.	Exposures exceed toxicity doses for great blue heron.	Comparison of site HQ for great blue heron to reference HQ of 10.

TABLE 7-21. BCFs FOR SURFACE SOIL COPC

Analyte	BCF	Dry/Wet Weight	Reference
Semivolatile Organics			
Acenaphthene	0.419 (1)	Dry	Beyer (1990)
Acenaphthylene	0.419 (1)	Dry	Beyer (1990)
Benzo(a)anthracene	0.125	Dry	Beyer (1990)
Benzo(a)pyrene	0.342	Dry	Beyer (1990)
Benzo(b)fluoranthene	0.319	Dry	Beyer (1990)
Benzo(g,h,i)perylene	0.244	Dry	Beyer (1990)
Butylbenzylphthalate	0.419 (2)	Dry	Beyer (1990)
Carbazole	0.419 (2)	Dry	Beyer (1990)
Chrysene	0.175	Dry	Beyer (1990)
Dibenzo(a,h)anthracene	0.368 (3)	Dry	Beyer (1990)
Dibenzofuran	0.419 (1)	Dry	Beyer (1990)
Fluoranthene	0.079	Dry	Beyer (1990)
Indeno(1,2,3 cd)pyrene	0.419	Dry	Beyer (1990)
2-Methylnaphthalene	0.419 (1)	Dry	Beyer (1990)
Phenanthrene	0.122	Dry	Beyer (1990)
Pyrene	0.092	Dry	Beyer (1990)
Pesticides			
Aldrin	5.5	Wet	Beyer (1990)
4,4'-DDT	9.0	Dry	Beyer (1990)
Endrin	3.5	Dry	Laird and Kroger (1981)
Endrin aldehyde	3.5	Dry	Laird and Kroger (1981)
Endosulfan sulfate	3.5	Dry	Laird and Kroger (1981)
Methoxychlor	6.25 (4)	Dry	Estimated
Inorganics			
Antimony	0.5 (5)	Wet	Estimated
Barium	0.36	Wet	Beyer and Stafford (1993)
Cadmium	27	Dry	Ireland (1983)
Chromium	0.49	Wet	Beyer and Stafford (1993)
Copper	0.52	Wet	Beyer and Stafford (1993)
Cyanide	0.0001 (6)	Wet	Estimated
Iron	0.38	Wet	Beyer and Stafford (1993)
Lead	0.45	Wet	Beyer and Stafford (1993)
Mercury	0.96	Wet	Beyer and Stafford (1993)
Zinc	1.8	Wet	Beyer and Stafford (1993)

NOTES:

1. Highest reported BCF for PAHs conservatively used.
2. Insufficient BCF data. As a result, the highest reported BCF for PAHs was conservatively used which would likely overestimate bioconcentration of these COPC from surface soil to earthworms.
3. BCF for dibenzo(a,j)anthracene.
4. Insufficient BCF data. As a result, a high dry weight BCF was conservatively used that is equivalent to 1 upon conversion to wet weight.
5. Insufficient BCF data. As a result, an estimated value similar to most of the inorganic COPC was used.
6. No bioaccumulation because cyanide is generally metabolized by microorganisms (Eisler 1991).

TABLE 7-22. COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR SHREWS TO TRVs

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Earthworm HQ	Percent Surface Soil HQ	Percent Surface Water HQ
B&M Railroad Landfill							
	Semivolatile Organics (mg/kg)						
	Acenaphthene	0.12	22	<0.1	18.3	81.7	0.0
	Acenaphthylene	0.12	11.1	<0.1	18.3	81.7	0.0
	Benzo(a)anthracene	0.22	5.72	<0.1	6.3	93.7	0.0
	Benzo(a)pyrene	0.25	1.257	0.2	15.5	84.5	0.0
	Benzo(b)fluoranthene	0.56	114	<0.1	14.6	85.4	0.0
	Benzo(g,h,i)perylene	0.13	206	<0.1	11.5	88.5	0.0
	Butylbenzylphthalate	0.21	45.4	<0.1	18.3	81.7	0.0
	Carbazole	0.11	14.3	<0.1	18.3	81.7	0.0
	Chrysene	0.26	283	<0.1	8.6	91.4	0.0
X	Dibenzo(a,h)anthracene	0.11	0.00172	65.3	16.4	83.6	0.0
	Dibenzofuran	0.12	9.63	<0.1	18.3	81.7	0.0
	Fluoranthene	0.37	15.8	<0.1	4.1	95.9	0.0
	Indeno(1,2,3-cd)pyrene	0.14	206	<0.1	18.3	81.7	0.0
	2-Methylnaphthalene	0.12	23.3	<0.1	18.3	81.7	0.0
	Phenanthrene	0.16	10.7	<0.1	6.1	93.9	0.0
	Pyrene	0.38	9.45	<0.1	4.7	95.1	0.3
	Pesticides and PCBs (mg/kg)						
	Aldrin	1.8E-03	0.252	<0.1	94.8	5.2	0.0
	4,4'-DDT	0.02	2.29	<0.1	82.8	17.2	0.0
	Endrin	0.01	0.116	<0.1	65.2	34.8	0.0
	Endrin Aldehyde	0.00	0.116	<0.1	65.2	34.8	0.0
	Endrin Ketone	0.01	0.116	<0.1	65.2	34.8	0.0
	Methoxychlor	0.02	11.4	<0.1	77.0	23.0	0.0
	Inorganics (mg/kg)		0				
X	Antimony	2.63	0.157	16.8	62.5	37.5	0.0
X	Barium	33.14	14.5	2.3	54.6	45.4	0.1
X	Cadmium	6.83	0.241	28.3	93.5	6.5	0.0
	Chromium	11.36	7820	<0.1	62.1	37.9	0.0
X	Copper	57.60	47.5	1.2	63.5	36.5	0.0
	Cyanide	0.22	19.6	<0.1	0.0	100.0	0.0

TABLE 7-22 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR SHREWS TO TRVs

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Earthworm HQ	Percent Surface Soil HQ	Percent Surface Water HQ
X	Iron	4670.70	1.93	2420.1	55.9	44.0	0.0
X	Lead	81.56	22.9	3.6	60.0	39.9	0.0
X	Mercury	0.26	0.0914	2.9	76.2	23.8	0.0
	Nickel	0.01	114	<0.1	0.0	0.0	100.0
	Silver	0.00	25.4	<0.1	0.0	0.0	100.0
	Vanadium	0.00	0.6	<0.1	0.0	0.0	100.0
X	Zinc	506.88	457	1.1	85.7	14.3	0.0
RSI Landfill							
	Semivolatile Organics (mg/kg)						
	Pyrene	1.1E-03	9.45	<0.1	0.0	0.0	100.0
	Pesticides and PCBs (mg/kg)						
	Aldrin	2.7E-07	0.252	<0.1	0.0	0.0	100.0
	Endrin	1.7E-04	0.116	<0.1	65.2	34.8	0.0
	Endrin Ketone	2.0E-04	0.116	<0.1	65.2	34.8	0.0
	Methoxychlor	3.3E-04	11.4	<0.1	0.0	100.0	0.0
	Inorganics (mg/kg)						
	Barium	0.02	14.5	<0.1	0.0	0.0	100.0
	Chromium	2.14	7820	<0.1	62.0	37.9	0.1
	Copper	0.01	47.5	<0.1	0.0	0.0	100.0
X	Iron	1286.21	1.93	666.4	55.8	44.0	0.2
	Lead	0.01	22.9	<0.1	0.0	0.0	100.0
	Mercury	0.00	0.0914	<0.1	0.0	0.0	100.0
	Nickel	0.01	114	<0.1	0.0	0.0	100.0
	Silver	0.00	25.4	<0.1	0.0	0.0	100.0
	Vanadium	0.00	0.6	<0.1	0.0	0.0	100.0
	Zinc	0.09	457	<0.1	0.0	0.0	100.0
B&M Locomotive Shop Disposal Area							
	Semivolatile Organics (mg/kg)						
	Acenaphthene	0.02	22	<0.1	18.3	81.7	0.0
	Acenaphthylene	0.01	11.1	<0.1	18.3	81.7	0.0
	Benzo(a)anthracene	0.04	5.72	<0.1	6.3	93.7	0.0

TABLE 7-22 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR SHREWS TO TRVs

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Earthworm HQ	Percent Surface Soil HQ	Percent Surface Water HQ
Benzo(a)pyrene	0.03	1.26	<0.1	15.5	84.5	0.0
Bis(2-ethylhexyl)phthalate	0.01	45.5	<0.1	14.6	85.4	0.0
Chrysene	0.05	283	<0.1	8.6	91.4	0.0
2-Methylnaphthalene	0.02	23.3	<0.1	18.3	81.7	0.0
Phenanthrene	0.09	10.7	<0.1	6.1	93.9	0.0
Pyrene	0.00	9.45	<0.1	0.0	0.0	100.0
Pesticides and PCBs (mg/kg)						
Aldrin	1.6E-03	0.252	<0.1	94.8	5.2	0.0
Endrin	3.0E-04	0.116	<0.1	65.2	34.8	0.0
Endrin Ketone	4.3E-04	0.116	<0.1	65.2	34.8	0.0
Methoxychlor	2.4E-03	11.4	<0.1	77.0	23.0	0.0
Inorganics (mg/kg)						
X Antimony	2.21	0.157	14.1	62.5	37.5	0.0
Barium	0.02	14.5	<0.1	0.0	0.0	100.0
Chromium	4.78	7820	<0.1	62.1	37.9	0.0
X Copper	117.09	47.5	2.5	63.5	36.5	0.0
X Iron	4604.57	1.93	2385.8	55.9	44.0	0.0
X Lead	83.90	22.9	3.7	60.0	39.9	0.0
Mercury	0.03	0.0914	0.3	76.2	23.8	0.1
Nickel	0.01	114	<0.1	0.0	0.0	100.0
Silver	0.00	25.4	<0.1	0.0	0.0	100.0
Vanadium	0.00	0.6	<0.1	0.0	0.0	100.0
Zinc	90.82	457	0.2	85.7	14.2	0.1

NOTES:

HQ = Hazard quotient.

X = Indicates a COPC with a HQ >= 1.

TABLE 7-23. COMPARISON OF MAXIMUM DIETARY DOSES FOR SHREWS TO TRVs

	COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Prey HQ	Perecnt Surface Soil HQ	Percent Surface Water HQ
	B&M Railroad Landfill						
	Semivolatile Organics (mg/kg)						
	Acenaphthene	0.02	22	<0.1	18.3	81.7	0.0
	Acenaphthylene	0.23	11.1	<0.1	18.3	81.7	0.0
	Benzo(a)anthracene	0.99	5.72	0.2	6.3	93.7	0.0
X	Benzo(a)pyrene	1.24	1.257	1.0	15.5	84.5	0.0
	Benzo(b)fluoranthene	2.25	114	<0.1	14.6	85.4	0.0
	Benzo(g,h,i)perylene	0.66	206	<0.1	11.5	88.5	0.0
	Butylbenzylphthalate	0.71	45.4	<0.1	18.3	81.7	0.0
	Carbazole	0.24	14.3	<0.1	18.3	81.7	0.0
	Chrysene	1.27	283	<0.1	8.6	91.4	0.0
X	Dibenzo(a,h)anthracene	0.29	0.00172	170.3	16.4	83.6	0.0
	Dibenzofuran	0.02	9.63	<0.1	18.3	81.7	0.0
	Fluoranthene	1.70	15.8	0.1	4.1	95.9	0.0
	Indeno(1,2,3-cd)pyrene	0.71	206	<0.1	18.3	81.7	0.0
	2-Methylnaphthalene	0.02	23.3	<0.1	18.3	81.7	0.0
	Phenanthrene	1.06	10.7	<0.1	6.1	93.9	0.0
	Pyrene	1.69	9.45	0.2	4.1	82.7	13.2
	Pesticides and PCBs (mg/kg)						
	Aldrin	4.6E-03	0.252	<0.1	91.6	5.0	3.4
	4,4'-DDT	7.8E-02	2.29	<0.1	82.8	17.2	0.0
	Endrin	2.3E-02	0.116	0.2	65.2	34.8	0.0
	Endrin Aldehyde	1.8E-02	0.116	0.2	65.2	34.8	0.0
	Endrin Ketone	2.8E-02	0.116	0.2	65.2	34.8	0.0
	Methoxychlor	4.3E-02	11.4	<0.1	77.0	23.0	0.0
	Inorganics (mg/kg)						
X	Antimony	24.11	0.157	153.6	62.5	37.5	0.0
X	Barium	118.54	14.5	8.2	54.5	45.3	0.2
X	Cadmium	4.95	0.241	20.6	59.1	40.9	0.0
	Chromium	46.72	7820	<0.1	62.1	37.9	0.0
X	Copper	164.44	47.5	3.5	63.4	36.5	0.1
	Cyanide	2.27	19.6	0.1	0.0	100.0	0.0

TABLE 7-23 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR SHREWS TO TRVs

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Prey HQ	Perecnt Surface Soil HQ	Percent Surface Water HQ
X	Iron	10177.63	1.93	5273.4	55.8	44.0	0.2
X	Lead	164.99	22.9	7.2	60.0	39.9	0.1
X	Mercury	0.83	0.0914	9.1	76.2	23.8	0.0
	Nickel	0.07	114	<0.1	0.0	0.0	100.0
	Silver	0.00	25.4	<0.1	0.0	0.0	100.0
	Vanadium	0.01	0.6	<0.1	0.0	0.0	100.0
X	Zinc	1799.43	457	3.9	85.7	14.3	0.1
<u>RSI Landfill</u>							
Semivolatile Organics (mg/kg)							
	Pyrene	0.22	9.45	<0.1	0.0	0.0	100.0
Pesticides and PCBs (mg/kg)							
	Aldrin	0.00	0.252	<0.1	0.0	0.0	100.0
	Endrin	0.00	0.116	<0.1	65.2	34.8	0.0
	Endrin Ketone	0.00	0.116	<0.1	65.2	34.8	0.0
	Methoxychlor	0.00	11.4	<0.1	77.0	23.0	0.0
Inorganics (mg/kg)							
	Barium	0.19	14.5	<0.1	0.0	0.0	100.0
	Chromium	3.65	7820	<0.1	61.9	37.8	0.2
	Copper	0.14	47.5	<0.1	0.0	0.0	100.0
X	Iron	1818.90	1.93	942.4	55.3	43.6	1.1
	Lead	0.14	22.9	<0.1	0.0	0.0	100.0
	Mercury	0.00	0.0914	<0.1	0.0	0.0	100.0
	Nickel	0.07	114	<0.1	0.0	0.0	100.0
	Silver	0.00	25.4	<0.1	0.0	0.0	100.0
	Vanadium	0.01	0.6	<0.1	0.0	0.0	100.0
	Zinc	1.14	457	<0.1	0.0	0.0	100.0
<u>B&M Locomotive Shop Disposal Area</u>							
Semivolatile Organics (mg/kg)							
	Acenaphthene	0.06	22	<0.1	18.3	81.7	0.0
	Acenaphthylene	0.00	11.1	<0.1	18.3	81.7	0.0
	Benzo(a)anthracene	0.14	5.72	<0.1	6.3	93.7	0.0

TABLE 7-23 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR SHREWS TO TRVs

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Prey HQ	Perecnt Surface Soil HQ	Percent Surface Water HQ
	Benzo(a)pyrene	0.12	1.26	<0.1	15.5	84.5	0.0
	Bis(2-ethylhexyl)phthalate	0.01	45.5	<0.1	14.6	85.4	0.0
	Chrysene	0.15	283	<0.1	8.6	91.4	0.0
	2-Methylnaphthalene	0.03	23.3	<0.1	18.3	81.7	0.0
	Phenanthrene	0.37	10.7	<0.1	6.1	93.9	0.0
	Pyrene	0.22	9.45	<0.1	0.0	0.0	100.0
	Pesticides and PCBs (mg/kg)						
	Aldrin	3.3E-03	0.252	<0.1	90.4	4.9	4.6
	Endrin	5.8E-04	0.116	<0.1	65.2	34.8	0.0
	Endrin Ketone	9.4E-04	0.116	<0.1	65.2	34.8	0.0
	Methoxychlor	4.8E-03	11.4	<0.1	77.0	23.0	0.0
	Inorganics (mg/kg)						
X	Antimony	8.25	0.157	52.5	62.5	37.5	0.0
	Barium	0.19	14.5	<0.1	0.0	0.0	100.0
	Chromium	13.44	7820	<0.1	62.0	37.9	0.1
X	Copper	500.22	47.5	10.5	63.4	36.5	0.0
X	Iron	13424.57	1.93	6955.7	55.9	44.0	0.2
X	Lead	345.89	22.9	15.1	60.0	39.9	0.0
	Mercury	0.05	0.0914	0.5	76.2	23.8	0.1
	Nickel	0.07	114	<0.1	0.0	0.0	100.0
	Silver	0.00	25.4	<0.1	0.0	0.0	100.0
	Vanadium	0.01	0.6	<0.1	0.0	0.0	100.0
	Zinc	336.68	457	0.7	85.5	14.2	0.3

NOTES:

HQ = Hazard quotient.

X = Indicates a COPC with a HQ >= 1.

TABLE 7-24. BCFs FOR SURFACE WATER COPC

Analyte	BCF	Reference
Pesticides		
Aldrin	114	Estimated (1)
alpha-Chlordane	9,558.73	Opresko et al. (1994)
gamma-Chlordane	9,558.73	Opresko et al. (1994)
4,4'-DDD	40,142.10	Opresko et al. (1994)
Methoxychlor	1,090	Estimated (1)
Inorganics		
Aluminum	231	Opresko et al. (1994)
Arsenic	17	Opresko et al. (1994)
Barium	150	NAS (1972)
Chromium	3	Opresko et al. (1994)
Cobalt	1	Estimated (2)
Copper	290	Opresko et al. (1994)
Iron	11	Estimated (2)
Lead	45	Opresko et al. (1994)
Manganese	84	AQUIRE (1990)
Mercury	81,700	USEPA (1986b)
Nickel	106	Opresko et al. (1994)
Selenium	470	USEPA (1987a)
Silver	150	USEPA (1987b)
Vanadium	1	Estimated (2)
Zinc	966	Opresko et al. (1994)

NOTES:

1. Estimated using the equation: Log BCF = 0.76 Log K_{ow} = 0.23 (Veith et al. 1979 in Spacie and Hamelink 1985).
2. No BCF data available for this COPC. In addition, this COPC is not known to bioconcentrate in surface water. As a result, a default BCF of 1.0 was used.

TABLE 7-25. BIOLOGICAL PARAMETERS OF AMPHIPODS AND BLUEGILL SUNFISH

Species	Parameter	Value	Units	Reference
Pontoporeia affinis	Food Assimilation Efficiency	0.2		Thomann et al. (1992)
(amphipods)	Growth Rate	0.035	1/day	Thomann et al. (1992)
	Food Ingestion Rate	0.186	g{l}/g{l}	Thomann et al. (1992)
	Lipid Fraction	0.03		Oliver & Niimi (1988)
	Amphipod Weight	0.002	grams(wet)	Thomann (1992)
Lepomis macrochirus	Food Assimilation Efficiency	0.5		Thomann et al. (1992)
(Bluegill)	Growth Rate	2.2E-03	1/day	Clement (1993)
	Food Ingestion Rate	0.036	g{l}/g{l}	Carlander (1977)
	Lipid Fraction	0.022		USACOE (1992)
	Fish Weight	54.6	grams(wet)	Clement (1993)

TABLE 7-26. SUMMARY OF ESTIMATED PESTICIDE AND PCB CONCENTRATIONS IN BENTHOS AND FISH

Analyte	Log K_{ow}	Average Concentration in Sediment (ug/kg)	Maximum Concentration in Sediment (ug/kg)	Benthic Attenuation Factor	Average Benthos Concentration (ug/kg (lp))	Maximum Benthos Concentration (ug/kg (lp))	Fish Attenuation Factor	Average Fish Concentration (ug/kg)	Maximum Fish Concentration (ug/kg)
West Middlesex Canal Group									
Aroclor 1248	6.11	258	2,000	1.1E+00	5.7E+00	4.4E+01	8.7E+01	1.1E+01	8.5E+01
alpha-Chlordane	4.78	3.61	18	7.0E-02	5.1E-03	2.6E-02	6.8E+00	7.7E-04	3.8E-03
gamma-Chlordane	4.78	2.91	18	7.0E-02	4.1E-03	2.6E-02	6.8E+00	6.2E-04	3.8E-03
DDD	5.99	7.15	34	9.1E-01	1.3E-01	6.3E-01	7.5E+01	2.2E-01	1.0E+00
DDE	5.69	4.14	18	5.1E-01	4.3E-02	1.9E-01	4.5E+01	4.3E-02	1.9E-01
Dieldrin	3.5	2.61	10	3.7E-03	2.0E-04	7.6E-04	3.7E-01	1.6E-06	6.2E-06
Endosulfan I	3.55	1.31	2	4.2E-03	1.1E-04	1.7E-04	4.2E-01	1.0E-06	1.6E-06
Endosulfan II	3.62	2.81	2	4.9E-03	2.8E-04	2.0E-04	4.9E-01	3.0E-06	2.1E-06
Endrin	5.6	2.84	5.3	4.2E-01	2.5E-02	4.6E-02	3.8E+01	2.1E-02	3.9E-02
Methoxychlor	4.3	12.9	7.6	2.3E-02	6.1E-03	3.6E-03	2.3E+00	3.1E-04	1.8E-04
Wetland 2 Group									
Aroclor 1248	6.11	52.4	570	1.1E+00	1.2E+00	1.3E+01	8.7E+01	2.2E+00	2.4E+01
Aroclor 1254	6.94	49.8	320	1.3E+00	1.3E+00	8.3E+00	1.1E+02	3.2E+00	2.1E+01
delta-HCH (delta-BHC)	4.1	1.83	3.3	1.5E-02	5.5E-04	9.9E-04	1.5E+00	1.8E-05	3.2E-05
DDD	5.99	9.23	83	9.1E-01	1.7E-01	1.5E+00	7.5E+01	2.8E-01	2.5E+00
DDE	5.69	5.42	47	5.1E-01	5.6E-02	4.9E-01	4.5E+01	5.6E-02	4.9E-01
Dieldrin	3.5	4.37	17	3.7E-03	3.3E-04	1.3E-03	3.7E-01	2.7E-06	1.0E-05
Endosulfan II	3.62	2.76	8	4.9E-03	2.8E-04	8.0E-04	4.9E-01	3.0E-06	8.6E-06
Endosulfan Sulfate	3.89	3.55	1.5	9.1E-03	6.6E-04	2.8E-04	9.1E-01	1.3E-05	5.5E-06
Endrin	5.6	4.11	15	4.2E-01	3.6E-02	1.3E-01	3.8E+01	3.0E-02	1.1E-01
Endrin Aldehyde	5.6	11.2	190	7.1E-01	1.6E-01	2.8E+00	8.8E+01	3.2E-01	5.3E+00
Endrin Ketone (1)	5.6	3.91	3.7	4.2E-01	3.4E-02	3.2E-02	3.8E+01	2.8E-02	2.7E-02
Methoxychlor	4.3	17.9	26	2.3E-02	8.5E-03	1.2E-02	2.3E+00	4.3E-04	6.3E-04
East Middlesex Canal									
DDD	5.99	4.78	21	9.1E-01	8.9E-02	3.9E-01	7.5E+01	1.5E-01	6.4E-01
DDE	5.69	2.72	7.2	5.1E-01	2.8E-02	7.5E-02	4.5E+01	2.8E-02	7.5E-02
Endosulfan I	3.55	1.6	1.2	4.2E-03	1.4E-04	1.0E-04	4.2E-01	1.2E-06	9.3E-07
Endosulfan Sulfate	3.62	3.13	0.44	9.1E-03	5.8E-04	8.2E-05	9.1E-01	1.2E-05	1.6E-06
Methoxychlor	4.3	17.9	0.42	2.3E-02	8.5E-03	2.0E-04	2.3E+00	4.3E-04	1.0E-05
Richardson Pond Group									
Aldrin	3.01	4.24	2.4	1.2E-03	1.0E-04	5.9E-05	1.2E-01	2.7E-07	1.6E-07

TABLE 7-26 (CONTINUED). SUMMARY OF ESTIMATED PESTICIDE AND PCB CONCENTRATIONS IN BENTHOS AND FISH

Analyte	Log K_{ow}	Average Concentration in Sediment (ug/kg)	Maximum Concentration in Sediment (ug/kg)	Benthic Attenuation Factor	Average Benthos Concentration (ug/kg (lp))	Maximum Benthos Concentration (ug/kg (lp))	Fish Attenuation Factor	Average Fish Concentration (ug/kg)	Maximum Fish Concentration (ug/kg)
DDD	5.99	8.55	37	9.1E-01	1.6E-01	6.9E-01	7.5E+01	2.6E-01	1.1E+00
DDE	5.69	8.64	20	5.1E-01	9.0E-02	2.1E-01	4.5E+01	9.0E-02	2.1E-01
DDT	5.98	6.8	9.6	8.9E-01	1.2E-01	1.7E-01	7.4E+01	2.0E-01	2.8E-01
Dieldrin	3.5	8	10	3.7E-03	6.1E-04	7.6E-04	3.7E-01	4.9E-06	6.2E-06
Endosulfan I	3.55	3.1	3.4	4.2E-03	2.6E-04	2.9E-04	4.2E-01	2.4E-06	2.6E-06
Endosulfan II	3.62	7.09	0.5	4.9E-03	7.1E-04	5.0E-05	4.9E-01	7.6E-06	5.4E-07
Endosulfan Sulfate	3.89	8.21	1.8	9.1E-03	1.5E-03	3.3E-04	9.1E-01	3.0E-05	6.7E-06
Endrin	5.6	8.7	14	4.2E-01	7.5E-02	1.2E-01	3.8E+01	6.4E-02	1.0E-01
Methoxychlor	4.3	32.4	12	2.3E-02	1.5E-02	5.7E-03	2.3E+00	7.8E-04	2.9E-04
Content Brook Wetland									
DDD	5.99	3.77	16.3	9.1E-01	7.0E-02	3.0E-01	7.5E+01	1.2E-01	5.0E-01
DDE	5.69	2.89	6.4	5.1E-01	3.0E-02	6.7E-02	4.5E+01	3.0E-02	6.7E-02
Dieldrin	3.5	2.47	2.7	3.7E-03	1.9E-04	2.0E-04	3.7E-01	1.5E-06	1.7E-06
Endosulfan I	3.55	1.48	0.39	4.2E-03	1.3E-04	3.3E-05	4.2E-01	1.1E-06	3.0E-07
Endosulfan II	3.62	3.55	9.4	4.9E-03	3.5E-04	9.4E-04	4.9E-01	3.8E-06	1.0E-05
Endosulfan Sulfate	3.89	2.91	0.3	9.1E-03	5.4E-04	5.6E-05	9.1E-01	1.1E-05	1.1E-06
Heptaclor Epoxide	2.7	1.06	0.33	5.9E-04	1.3E-05	4.0E-06	5.9E-02	1.6E-08	5.1E-09
Methoxychlor	4.3	12.2	14	2.3E-02	5.8E-03	6.6E-03	2.3E+00	2.9E-04	3.4E-04

Notes:

1. Assumed log K_{ow} of Endrin for Endrin Ketone.

TABLE 7-27. COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
West Middlesex Canal Group						
Semivolatile Organics (mg/kg)						
Benzo(a)anthracene	7.3E-03	0.105	<0.1	100.0	0.0	0.0
Benzo(b)fluoranthene	7.0E-03	2.11	<0.1	100.0	0.0	0.0
Benzo(k)fluoranthene	7.5E-03	2.11	<0.1	100.0	0.0	0.0
Butylbenzylphthalate	8.2E-03	0.838	<0.1	100.0	0.0	0.0
Chrysene	6.5E-03	5.22	<0.1	100.0	0.0	0.0
Fluoranthene	6.7E-03	0.291	<0.1	100.0	0.0	0.0
2-Methylnaphthalene	7.2E-03	0.43	<0.1	100.0	0.0	0.0
Phenanthrene	6.7E-03	1.97	<0.1	100.0	0.0	0.0
Pyrene	7.6E-03	0.174	<0.1	100.0	0.0	0.0
Pesticides and PCBs (mg/kg)						
Aldrin	1.2E-05	0.0371	<0.1	0.0	99.8	0.2
alpha-Chlordane	7.3E-06	0.601	<0.1	89.4	10.6	0.0
gamma-Chlordane	5.9E-06	0.601	<0.1	89.4	10.6	0.0
4,4'-DDD	2.3E-04	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	5.0E-05	0.933	<0.1	14.8	85.2	0.0
Dieldrin	4.7E-06	0.0447	<0.1	100.0	0.0	0.0
Endosulfan I	2.4E-06	5.51	<0.1	100.0	0.0	0.0
Endosulfan II	5.1E-06	5.51	<0.1	99.9	0.1	0.0
Endrin	2.6E-05	0.235	<0.1	19.8	80.2	0.0
Methoxychlor	2.4E-05	62.2	<0.1	98.7	1.3	0.0
Aroclor-1248	1.1E-02	0.42	<0.1	4.1	95.9	0.0
Inorganics (mg/kg)						
Aluminum	1.5E+01	44.8	0.3	100.0	0.0	0.0
Arsenic	3.0E-02	0.673	<0.1	100.0	0.0	0.0
Barium	8.3E-02	7.72	<0.1	100.0	0.0	0.0
Beryllium	1.0E-03	0.0348	<0.1	100.0	0.0	0.0
Cadmium	1.4E-03	1.14	<0.1	100.0	0.0	0.0
Chromium	4.6E-02	0.806	<0.1	100.0	0.0	0.0
Cobalt	1.5E-02	0.769	<0.1	100.0	0.0	0.0

TABLE 7-27 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Copper	6.6E-02	12.3	<0.1	100.0	0.0	0.0
	Iron	1.9E+01	25.9	0.7	100.0	0.0	0.0
	Lead	1.6E-01	1.46	0.1	100.0	0.0	0.0
	Manganese	7.9E-01	4.64	0.2	100.0	0.0	0.0
	Mercury	1.9E-04	0.005	<0.1	100.0	0.0	0.0
	Nickel	3.2E-02	53.3	<0.1	100.0	0.0	0.0
	Selenium	2.8E-03	0.314	<0.1	100.0	0.0	0.0
	Vanadium	4.3E-02	8.94	<0.1	100.0	0.0	0.0
	Zinc	1.9E-01	2.35	<0.1	100.0	0.0	0.0
Wetland 2 Group							
Semivolatile Organics (mg/kg)							
	Acenaphthene	1.7E-03	1.76	<0.1	100.0	0.0	0.0
	Acenaphthylene	1.7E-03	0.205	<0.1	100.0	0.0	0.0
	Anthracene	1.8E-03	174	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	4.4E-03	0.105	<0.1	100.0	0.0	0.0
	Benzo(a)pyrene	2.8E-03	0.0232	0.1	100.0	0.0	0.0
	Benzo(b)fluoranthene	5.6E-03	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	2.6E-03	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	2.7E-03	2.11	<0.1	100.0	0.0	0.0
	Butylbenzylphthalate	2.6E-03	0.838	<0.1	100.0	0.0	0.0
	Carbazole	1.7E-03	0.264	<0.1	100.0	0.0	0.0
	Chrysene	3.3E-03	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	2.7E-03	0.000032	83.3	100.0	0.0	0.0
	Fluoranthene	5.1E-03	0.291	<0.1	100.0	0.0	0.0
	Fluorene	1.2E-03	1.76	<0.1	100.0	0.0	0.0
	Indeno(1,2,3-cd)pyrene	2.8E-03	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	1.6E-03	0.43	<0.1	100.0	0.0	0.0
	4-Methylphenol	1.7E-03	1.97	<0.1	100.0	0.0	0.0
	Naphthalene	1.6E-03	0.621	<0.1	100.0	0.0	0.0
	N-Nitrosodiphenylamine	2.6E-03	6.98	<0.1	100.0	0.0	0.0
	Phenanthrene	3.9E-03	1.97	<0.1	100.0	0.0	0.0

TABLE 7-27 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
Pyrene	6.0E-03	0.174	<0.1	98.3	0.0	1.7
Pesticides and PCBs (mg/kg)						
delta-BHC	3.3E-06	0.224	<0.1	98.7	0.5	0.8
4,4'-DDD	3.0E-04	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	6.6E-05	0.933	<0.1	14.8	85.2	0.0
Dieldrin	7.9E-06	0.0447	<0.1	100.0	0.0	0.0
Endosulfan II	5.0E-06	5.51	<0.1	99.9	0.1	0.0
Endosulfan Sulfate	6.4E-06	5.51	<0.1	99.8	0.2	0.0
Endrin	3.7E-05	0.235	<0.1	19.8	80.2	0.0
Endrin Aldehyde	3.4E-04	0.235	<0.1	6.0	94.0	0.0
Endrin Ketone	3.5E-05	0.235	<0.1	19.9	80.1	0.0
Methoxychlor	3.3E-05	62.2	<0.1	98.7	1.3	0.0
Aroclor-1248	2.3E-03	0.42	<0.1	4.1	95.9	0.0
Aroclor-1254	3.3E-03	0.135	<0.1	2.7	97.3	0.0
Inorganics (mg/kg)						
Aluminum	1.3E+01	44.8	0.3	100.0	0.0	0.0
X Antimony	2.2E-02	0.00291	7.4	100.0	0.0	0.0
Arsenic	2.7E-02	0.673	<0.1	100.0	0.0	0.0
Barium	9.4E-01	7.72	0.1	11.8	88.0	0.1
Beryllium	1.1E-03	0.0348	<0.1	100.0	0.0	0.0
Cadmium	8.3E-04	1.14	<0.1	100.0	0.0	0.0
Chromium	3.8E-02	0.806	<0.1	97.6	2.2	0.2
Cobalt	1.4E-02	0.769	<0.1	100.0	0.0	0.0
Copper	6.7E-01	12.3	<0.1	69.7	30.3	0.0
Iron	2.6E+01	25.9	1.0	95.5	3.6	0.9
Lead	6.1E-01	1.46	0.4	89.1	10.8	0.1
Manganese	5.8E-01	4.64	0.1	100.0	0.0	0.0
X Mercury	4.8E-01	0.005	96.1	0.1	99.9	0.0
Nickel	2.1E-02	53.3	<0.1	100.0	0.0	0.0
Selenium	3.7E-03	0.314	<0.1	100.0	0.0	0.0
Silver	1.6E-03	0.469	<0.1	100.0	0.0	0.0

TABLE 7-27 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
Vanadium	2.9E-02	8.94	<0.1	100.0	0.0	0.0
X Zinc	3.4E+00	2.35	1.5	8.7	91.2	0.0
East Middlesex Canal Group						
Pesticides and PCBs (mg/kg)						
4,4'-DDD	1.6E-04	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	3.3E-05	0.933	<0.1	14.8	85.2	0.0
Endosulfan I	2.9E-06	0.0447	<0.1	100.0	0.0	0.0
Endosulfan Sulfate	5.6E-06	5.51	<0.1	99.8	0.2	0.0
Methoxychlor	1.5E-03	62.2	<0.1	2.2	97.8	0.0
Inorganics (mg/kg)						
Arsenic	8.9E-03	0.673	<0.1	100.0	0.0	0.0
Barium	8.1E-02	7.72	<0.1	100.0	0.0	0.0
Cobalt	8.2E-03	0.769	<0.1	100.0	0.0	0.0
Lead	9.1E-02	1.46	<0.1	100.0	0.0	0.0
Manganese	9.9E-01	4.64	0.2	100.0	0.0	0.0
Mercury	2.3E-04	0.005	<0.1	100.0	0.0	0.0
Selenium	1.4E-03	0.314	<0.1	100.0	0.0	0.0
Vanadium	1.5E-02	8.94	<0.1	100.0	0.0	0.0
Richardson Pond Group						
Semivolatile Organics (mg/kg)						
Acenaphthene	8.7E-03	1.76	<0.1	100.0	0.0	0.0
Anthracene	8.6E-03	174	<0.1	100.0	0.0	0.0
Benzo(a)anthracene	1.2E-02	0.105	0.1	100.0	0.0	0.0
Benzo(a)pyrene	9.9E-03	0.0232	0.4	100.0	0.0	0.0
Benzo(b)fluoranthene	1.1E-02	2.11	<0.1	100.0	0.0	0.0
Benzo(g,h,i)perylene	9.3E-03	3.8	<0.1	100.0	0.0	0.0
Benzo(k)fluoranthene	1.0E-02	2.11	<0.1	100.0	0.0	0.0
Butylbenzylphthalate	8.8E-03	0.838	<0.1	100.0	0.0	0.0
Chrysene	1.1E-02	5.22	<0.1	100.0	0.0	0.0
X Dibenzo(a,h)anthracene	7.7E-03	0.000032	241.9	100.0	0.0	0.0
Fluoranthene	1.5E-02	0.291	<0.1	100.0	0.0	0.0

TABLE 7-27 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
Fluorene	8.5E-03	1.76	<0.1	100.0	0.0	0.0
Indeno(1,2,3-cd)pyrene	8.8E-03	3.8	<0.1	100.0	0.0	0.0
2-Methylnaphthalene	9.2E-03	0.43	<0.1	100.0	0.0	0.0
4-Methylphenol	8.6E-03	1.97	<0.1	100.0	0.0	0.0
Naphthalene	9.1E-03	0.621	<0.1	100.0	0.0	0.0
Phenanthrene	1.5E-02	1.97	<0.1	100.0	0.0	0.0
Pyrene	2.0E-02	0.174	0.1	99.6	0.0	0.4
Pesticides and PCBs (mg/kg)						
Aldrin	7.6E-06	0.0371	<0.1	100.0	0.0	0.0
4,4'-DDD	2.8E-04	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	1.1E-04	0.933	<0.1	14.8	85.2	0.0
4,4'-DDT	2.1E-04	0.00318	<0.1	5.7	94.3	0.0
Dieldrin	1.4E-05	0.0447	<0.1	100.0	0.0	0.0
Endosulfan I	5.6E-06	5.51	<0.1	100.0	0.0	0.0
Endosulfan II	1.3E-05	5.51	<0.1	99.9	0.1	0.0
Endosulfan Sulfate	1.5E-05	5.51	<0.1	99.8	0.2	0.0
Endrin	7.9E-05	0.235	<0.1	19.8	80.2	0.0
Methoxychlor	5.9E-05	62.2	<0.1	98.7	1.3	0.0
Inorganics (mg/kg)						
Aluminum	1.3E+01	44.8	0.3	100.0	0.0	0.0
Arsenic	1.2E-02	0.673	<0.1	100.0	0.0	0.0
Barium	1.5E+00	7.72	0.2	8.0	91.8	0.2
Beryllium	5.1E-03	0.0348	0.1	28.6	70.4	0.9
Cadmium	8.2E-04	1.14	<0.1	100.0	0.0	0.0
Chromium	3.5E-02	0.806	<0.1	100.0	0.0	0.0
Cobalt	1.1E-02	0.769	<0.1	100.0	0.0	0.0
Copper	8.3E-02	12.3	<0.1	100.0	0.0	0.0
Iron	2.1E+01	25.9	0.8	85.7	11.4	2.9
Lead	2.2E-01	1.46	0.2	60.5	39.2	0.2
Manganese	4.1E-01	4.64	<0.1	100.0	0.0	0.0
Mercury	7.1E-04	0.005	0.1	99.8	0.0	0.2

TABLE 7-27 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Nickel	2.8E-02	53.3	<0.1	100.0	0.0	0.0
	Selenium	2.1E-03	0.314	<0.1	100.0	0.0	0.0
	Silver	4.5E-02	0.469	<0.1	4.1	95.7	0.2
	Vanadium	3.5E-02	8.94	<0.1	100.0	0.0	0.0
X	Zinc	2.8E+00	2.35	1.2	8.7	91.3	0.0
<u>Content Brook Wetland Group</u>							
Semivolatile Organics (mg/kg)							
	Acenaphthene	5.4E-04	1.76	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	6.0E-04	0.105	<0.1	100.0	0.0	0.0
	Benzo(a)pyrene	5.7E-04	0.0232	<0.1	100.0	0.0	0.0
	Benzo(b)fluoranthene	6.3E-04	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	5.7E-04	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	7.1E-04	2.11	<0.1	100.0	0.0	0.0
	Carbazole	5.6E-04	0.264	<0.1	100.0	0.0	0.0
	Chrysene	6.4E-04	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	5.5E-04	0.000032	17.2	100.0	0.0	0.0
	Fluoranthene	8.3E-04	0.291	<0.1	100.0	0.0	0.0
	Fluorene	5.6E-04	1.76	<0.1	100.0	0.0	0.0
	Indeno(1,2,3-cd)pyrene	4.8E-04	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	4.9E-04	0.43	<0.1	100.0	0.0	0.0
	Naphthalene	3.0E-04	0.621	<0.1	100.0	0.0	0.0
	Phenanthrene	7.1E-04	1.97	<0.1	100.0	0.0	0.0
	Pyrene	9.2E-04	0.174	<0.1	89.2	0.0	10.8
Pesticides and PCBs (mg/kg)							
	Aldrin	3.2E-05	0.0371	<0.1	0.0	99.8	0.2
	4,4'-DDD	1.2E-04	3.14	<0.1	5.5	94.5	0.0
	4,4'-DDE	3.5E-05	0.933	<0.1	14.8	85.2	0.0
	gamma-Chlordane	1.5E-03	0.601	<0.1	0.0	100.0	0.0
	Dieldrin	4.4E-06	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan I	2.7E-06	5.51	<0.1	100.0	0.0	0.0
	Endosulfan II	6.0E-06	5.51	<0.1	99.9	0.1	0.0

TABLE 7-27 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

	COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Endosulfan Sulfate	5.2E-06	5.51	<0.1	99.8	0.2	0.0
	Heptachlor Epoxide	1.9E-06	0.572	<0.1	100.0	0.0	0.0
	Methoxychlor	2.2E-05	62.2	<0.1	98.7	1.3	0.0
	Inorganics (mg/kg)						
X	Aluminum	2.7E+02	44.8	5.9	5.1	94.8	0.1
X	Arsenic	3.7E+00	0.673	5.5	2.1	96.5	1.4
X	Barium	3.1E+01	7.72	4.0	0.4	99.5	0.2
	Chromium	3.0E-02	0.806	<0.1	71.2	26.6	2.2
	Cobalt	1.2E-02	0.769	<0.1	84.7	12.3	3.1
	Copper	5.1E-01	12.3	<0.1	4.5	95.4	0.1
X	Iron	7.3E+01	25.9	2.8	45.1	44.0	11.0
	Lead	2.3E-01	1.46	0.2	23.7	75.8	0.4
X	Manganese	2.7E+01	4.64	5.9	2.8	97.0	0.3
	Nickel	3.2E-01	53.3	<0.1	4.0	95.8	0.2
X	Selenium	3.5E-01	0.314	1.1	0.5	99.4	0.1
	Silver	2.1E-01	0.469	0.4	1.0	98.9	0.2
	Vanadium	3.9E-02	8.94	<0.1	85.8	11.4	2.8
X	Zinc	1.1E+01	2.35	4.6	0.5	99.5	0.0

HQ = Hazard quotient.

X = Indicates a COPC with a HQ >=1.

TABLE 7-28. COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
West Middlesex Canal Group						
Semivolatile Organics (mg/kg)						
Benzo(a)anthracene	7.3E-03	0.105	<0.1	100.0	0.0	0.0
Benzo(b)fluoranthene	7.0E-03	2.11	<0.1	100.0	0.0	0.0
Benzo(k)fluoranthene	7.5E-03	2.11	<0.1	100.0	0.0	0.0
Butylbenzylphthalate	8.2E-03	0.838	<0.1	100.0	0.0	0.0
Chrysene	6.5E-03	5.22	<0.1	100.0	0.0	0.0
Fluoranthene	6.7E-03	0.291	<0.1	100.0	0.0	0.0
2-Methylnaphthalene	7.2E-03	0.43	<0.1	100.0	0.0	0.0
Phenanthrene	6.7E-03	1.97	<0.1	100.0	0.0	0.0
Pyrene	7.6E-03	0.174	<0.1	100.0	0.0	0.0
Pesticides and PCBs (mg/kg)						
alpha-Chlordane	7.3E-06	0.601	<0.1	89.4	10.6	0.0
gamma-Chlordane	5.9E-06	0.601	<0.1	89.4	10.6	0.0
4,4'-DDD	2.3E-04	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	5.0E-05	0.933	<0.1	14.8	85.2	0.0
Dieldrin	4.7E-06	0.0447	<0.1	100.0	0.0	0.0
Endosulfan I	2.4E-06	5.51	<0.1	100.0	0.0	0.0
Endosulfan II	5.1E-06	5.51	<0.1	99.9	0.1	0.0
Endrin	2.6E-05	0.235	<0.1	19.8	80.2	0.0
Methoxychlor	2.4E-05	62.2	<0.1	98.7	1.3	0.0
Aroclor-1248	1.1E-02	0.42	<0.1	4.1	95.9	0.0
Inorganics (mg/kg)						
Aluminum	1.5E+01	44.8	0.3	100.0	0.0	0.0
Arsenic	3.0E-02	0.673	<0.1	100.0	0.0	0.0
Barium	8.3E-02	7.72	<0.1	100.0	0.0	0.0
Beryllium	1.0E-03	0.0348	<0.1	100.0	0.0	0.0
Cadmium	1.4E-03	1.14	<0.1	100.0	0.0	0.0
Chromium	4.6E-02	0.806	<0.1	100.0	0.0	0.0
Cobalt	1.5E-02	0.769	<0.1	100.0	0.0	0.0
Copper	6.6E-02	12.3	<0.1	100.0	0.0	0.0

TABLE 7-28 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Iron	1.9E+01	25.9	0.7	100.0	0.0	0.0
	Lead	1.6E-01	1.46	0.1	100.0	0.0	0.0
	Manganese	7.9E-01	4.64	0.2	100.0	0.0	0.0
	Mercury	1.9E-04	0.005	<0.1	100.0	0.0	0.0
	Nickel	3.2E-02	53.3	<0.1	100.0	0.0	0.0
	Selenium	2.8E-03	0.314	<0.1	100.0	0.0	0.0
	Vanadium	4.3E-02	8.94	<0.1	100.0	0.0	0.0
	Zinc	1.9E-01	2.35	<0.1	100.0	0.0	0.0
Wetland 2 Group							
	Semivolatile Organics (mg/kg)						
	Acenaphthene	1.7E-03	1.76	<0.1	100.0	0.0	0.0
	Acenaphthylene	1.7E-03	0.205	<0.1	100.0	0.0	0.0
	Anthracene	1.8E-03	174	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	4.4E-03	0.105	<0.1	100.0	0.0	0.0
	Benzo(a)pyrene	2.8E-03	0.0232	0.1	100.0	0.0	0.0
	Benzo(b)fluoranthene	5.6E-03	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	2.6E-03	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	2.7E-03	2.11	<0.1	100.0	0.0	0.0
	Butylbenzylphthalate	2.6E-03	0.838	<0.1	100.0	0.0	0.0
	Carbazole	1.7E-03	0.264	<0.1	100.0	0.0	0.0
	Chrysene	3.3E-03	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	2.7E-03	0.000032	83.3	100.0	0.0	0.0
	Fluoranthene	5.1E-03	0.291	<0.1	100.0	0.0	0.0
	Fluorene	1.2E-03	1.76	<0.1	100.0	0.0	0.0
	Indeno(1,2,3-cd)pyrene	2.8E-03	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	1.6E-03	0.43	<0.1	100.0	0.0	0.0
	4-Methylphenol	1.7E-03	1.97	<0.1	100.0	0.0	0.0
	Naphthalene	1.6E-03	0.621	<0.1	100.0	0.0	0.0
	N-Nitrosodiphenylamine	2.6E-03	6.98	<0.1	100.0	0.0	0.0
	Phenanthrene	3.9E-03	1.97	<0.1	100.0	0.0	0.0
	Pyrene	6.0E-03	0.174	<0.1	98.2	0.0	1.8

TABLE 7-28 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
Pesticides and PCBs (mg/kg)						
delta-BHC	3.3E-06	0.224	<0.1	99.5	0.5	0.0
4,4'-DDD	3.0E-04	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	6.6E-05	0.933	<0.1	14.8	85.2	0.0
Dieldrin	7.9E-06	0.0447	<0.1	100.0	0.0	0.0
Endosulfan II	5.0E-06	5.51	<0.1	99.9	0.1	0.0
Endosulfan Sulfate	6.4E-06	5.51	<0.1	99.8	0.2	0.0
Endrin	3.7E-05	0.235	<0.1	19.8	80.2	0.0
Endrin Aldehyde	3.4E-04	0.235	<0.1	6.0	94.0	0.0
Endrin Ketone	3.5E-05	0.235	<0.1	19.9	80.1	0.0
Methoxychlor	3.3E-05	62.2	<0.1	98.7	1.3	0.0
Aroclor-1248	2.3E-03	0.42	<0.1	4.1	95.9	0.0
Aroclor-1254	3.3E-03	0.135	<0.1	2.7	97.3	0.0
Inorganics (mg/kg)						
Aluminum	1.3E+01	44.8	0.3	100.0	0.0	0.0
X Antimony	2.2E-02	0.00291	7.4	100.0	0.0	0.0
Arsenic	2.7E-02	0.673	<0.1	100.0	0.0	0.0
Barium	1.5E+00	7.72	0.2	7.6	92.2	0.2
Beryllium	1.1E-03	0.0348	<0.1	100.0	0.0	0.0
Cadmium	8.3E-04	1.14	<0.1	100.0	0.0	0.0
Chromium	3.9E-02	0.806	<0.1	95.8	3.8	0.3
Cobalt	1.4E-02	0.769	<0.1	100.0	0.0	0.0
Copper	1.8E+00	12.3	0.1	26.3	73.6	0.1
X Iron	2.5E+01	25.9	1.0	96.1	3.1	0.8
Lead	7.6E-01	1.46	0.5	71.1	28.7	0.2
Manganese	5.8E-01	4.64	0.1	100.0	0.0	0.0
Mercury	2.9E-04	0.005	<0.1	100.0	0.0	0.0
Nickel	2.6E-01	53.3	<0.1	8.0	91.8	0.2
Selenium	3.7E-03	0.314	<0.1	100.0	0.0	0.0
Silver	2.7E-02	0.469	<0.1	5.9	93.9	0.2
Vanadium	2.9E-02	8.94	<0.1	98.2	1.4	0.4

TABLE 7-28 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
X Zinc	3.4E+01	2.35	14.3	0.9	99.1	0.0
East Middlesex Canal Group						
Pesticides and PCBs (mg/kg)						
4,4'-DDD	1.6E-04	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	3.3E-05	0.933	<0.1	14.8	85.2	0.0
Endosulfan I	2.9E-06	0.0447	<0.1	100.0	0.0	0.0
Endosulfan Sulfate	5.6E-06	5.51	<0.1	99.8	0.2	0.0
Methoxychlor	3.3E-05	62.2	<0.1	98.7	1.3	0.0
Inorganics (mg/kg)						
Arsenic	8.9E-03	0.673	<0.1	100.0	0.0	0.0
Barium	8.1E-02	7.72	<0.1	100.0	0.0	0.0
Cobalt	8.2E-03	0.769	<0.1	100.0	0.0	0.0
Lead	9.1E-02	1.46	<0.1	100.0	0.0	0.0
Manganese	9.9E-01	4.64	0.2	100.0	0.0	0.0
Mercury	2.3E-04	0.005	<0.1	100.0	0.0	0.0
Selenium	1.4E-03	0.314	<0.1	100.0	0.0	0.0
Vanadium	1.5E-02	8.94	<0.1	100.0	0.0	0.0
Richardson Pond Group						
Semivolatile Organics (mg/kg)						
Acenaphthene	8.7E-03	1.76	<0.1	100.0	0.0	0.0
Anthracene	8.6E-03	174	<0.1	100.0	0.0	0.0
Benzo(a)anthracene	1.2E-02	0.105	0.1	100.0	0.0	0.0
Benzo(a)pyrene	9.9E-03	0.0232	0.4	100.0	0.0	0.0
Benzo(b)fluoranthene	1.1E-02	2.11	<0.1	100.0	0.0	0.0
Benzo(g,h,i)perylene	9.3E-03	3.8	<0.1	100.0	0.0	0.0
Benzo(k)fluoranthene	1.0E-02	2.11	<0.1	100.0	0.0	0.0
Butylbenzylphthalate	8.8E-03	0.838	<0.1	100.0	0.0	0.0
Chrysene	1.1E-02	5.22	<0.1	100.0	0.0	0.0
X Dibenzo(a,h)anthracene	7.7E-03	0.000032	241.9	100.0	0.0	0.0
Fluoranthene	1.5E-02	0.291	<0.1	100.0	0.0	0.0
Fluorene	8.5E-03	1.76	<0.1	100.0	0.0	0.0

TABLE 7-28 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
Indeno(1,2,3-cd)pyrene	8.8E-03	3.8	<0.1	100.0	0.0	0.0
2-Methylnaphthalene	9.2E-03	0.43	<0.1	100.0	0.0	0.0
4-Methylphenol	8.6E-03	1.97	<0.1	100.0	0.0	0.0
Naphthalene	9.1E-03	0.621	<0.1	100.0	0.0	0.0
Phenanthrene	1.5E-02	1.97	<0.1	100.0	0.0	0.0
Pyrene	2.0E-02	0.174	0.1	99.5	0.0	0.5
Pesticides and PCBs (mg/kg)						
Aldrin	7.6E-06	0.0371	<0.1	100.0	0.0	0.0
4,4'-DDD	2.1E-02	3.14	<0.1	0.1	99.9	0.0
4,4'-DDE	1.1E-04	0.933	<0.1	14.8	85.2	0.0
4,4'-DDT	2.1E-04	0.00318	<0.1	5.7	94.3	0.0
Dieldrin	1.4E-05	0.0447	<0.1	100.0	0.0	0.0
Endosulfan I	5.6E-06	5.51	<0.1	100.0	0.0	0.0
Endosulfan II	1.3E-05	5.51	<0.1	99.9	0.1	0.0
Endosulfan Sulfate	1.5E-05	5.51	<0.1	99.8	0.2	0.0
Endrin	7.9E-05	0.235	<0.1	19.8	80.2	0.0
Methoxychlor	5.9E-05	62.2	<0.1	98.7	1.3	0.0
Inorganics (mg/kg)						
X Aluminum	1.5E+02	44.8	3.5	8.3	91.6	0.1
Arsenic	1.2E-02	0.673	<0.1	100.0	0.0	0.0
Barium	2.3E+00	7.72	0.3	5.2	94.6	0.2
Beryllium	1.5E-03	0.0348	<0.1	100.0	0.0	0.0
Cadmium	8.2E-04	1.14	<0.1	100.0	0.0	0.0
Chromium	3.9E-02	0.806	<0.1	89.1	10.1	0.8
Cobalt	1.1E-02	0.769	<0.1	100.0	0.0	0.0
Copper	1.3E+00	12.3	0.1	6.3	93.6	0.1
Iron	2.1E+01	25.9	0.8	83.4	13.3	3.3
Lead	5.1E-01	1.46	0.4	26.3	73.3	0.4
Manganese	4.1E-01	4.64	<0.1	100.0	0.0	0.0
Mercury	7.1E-04	0.005	0.1	100.0	0.0	0.0
Nickel	2.8E-02	53.3	<0.1	100.0	0.0	0.0

TABLE 7-28 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

	COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Selenium	1.1E-01	0.314	0.3	2.0	98.0	0.1
	Silver	4.2E-02	0.469	<0.1	4.5	95.4	0.2
	Vanadium	3.7E-02	8.94	<0.1	93.9	4.8	1.2
X	Zinc	3.6E+01	2.35	15.3	0.7	99.3	0.0
	Content Brook Wetland Group						
	Semivolatile Organics (mg/kg)						
	Acenaphthene	5.4E-04	1.76	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	6.0E-04	0.105	<0.1	100.0	0.0	0.0
	Benzo(a)pyrene	5.7E-04	0.0232	<0.1	100.0	0.0	0.0
	Benzo(b)fluoranthene	6.3E-04	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	5.7E-04	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	7.1E-04	2.11	<0.1	100.0	0.0	0.0
	Carbazole	5.6E-04	0.264	<0.1	100.0	0.0	0.0
	Chrysene	6.4E-04	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	5.5E-04	0.000032	17.2	100.0	0.0	0.0
	Fluoranthene	8.3E-04	0.291	<0.1	100.0	0.0	0.0
	Fluorene	5.6E-04	1.76	<0.1	100.0	0.0	0.0
	Indeno(1,2,3-cd)pyrene	4.8E-04	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	4.9E-04	0.43	<0.1	100.0	0.0	0.0
	Naphthalene	3.0E-04	0.621	<0.1	100.0	0.0	0.0
	Phenanthrene	7.1E-04	1.97	<0.1	100.0	0.0	0.0
	Pyrene	8.2E-04	0.174	<0.1	100.0	0.0	0.0
	Pesticides and PCBs (mg/kg)						
	4,4'-DDD	1.2E-04	3.14	<0.1	5.5	94.5	0.0
	4,4'-DDE	3.5E-05	0.933	<0.1	14.8	85.2	0.0
	alpha-Chlordane	1.7E-03	0.601	<0.1	0.0	100.0	0.0
	Dieldrin	4.4E-06	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan I	2.7E-06	5.51	<0.1	100.0	0.0	0.0
	Endosulfan II	6.0E-06	5.51	<0.1	99.9	0.1	0.0
	Endosulfan Sulfate	5.2E-06	5.51	<0.1	99.8	0.2	0.0
	Heptachlor Epoxide	1.9E-06	0.572	<0.1	100.0	0.0	0.0

TABLE 7-28 (Continued). COMPARISON OF ARITHMETIC MEAN DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
Methoxychlor	2.2E-05	62.2	<0.1	98.7	1.3	0.0
Inorganics (mg/kg)						
X Aluminum	6.4E+01	44.8	1.4	21.3	78.6	0.1
Arsenic	3.6E-01	0.673	0.5	21.5	77.3	1.1
Barium	3.3E+00	7.72	0.4	3.4	96.4	0.2
Chromium	2.3E-02	0.806	<0.1	91.6	7.7	0.6
Cobalt	9.9E-03	0.769	<0.1	100.0	0.0	0.0
Copper	2.0E-01	12.3	<0.1	11.7	88.2	0.1
X Iron	3.6E+01	25.9	1.4	91.5	6.8	1.7
Lead	4.2E-01	1.46	0.3	13.0	86.5	0.5
Manganese	7.5E-01	4.64	0.2	100.0	0.0	0.0
Nickel	1.3E-02	53.3	<0.1	100.0	0.0	0.0
Selenium	1.8E-03	0.314	<0.1	100.0	0.0	0.0
Silver	2.1E-03	0.469	<0.1	100.0	0.0	0.0
Vanadium	3.5E-02	8.94	<0.1	97.4	2.1	0.5
Zinc	5.6E-02	2.35	<0.1	100.0	0.0	0.0

HQ = Hazard quotient.

X = Indicates a COPC with a HQ >=1.

TABLE 7-29. COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
West Middlesex Canal Group						
Semivolatile Organics (mg/kg)						
Benzo(a)anthracene	4.7E-03	0.105	<0.1	100.0	0.0	0.0
Benzo(b)fluoranthene	6.5E-03	2.11	<0.1	100.0	0.0	0.0
Benzo(k)fluoranthene	5.4E-03	2.11	<0.1	100.0	0.0	0.0
Butylbenzylphthalate	6.3E-04	0.838	<0.1	100.0	0.0	0.0
Chrysene	6.5E-03	5.22	<0.1	100.0	0.0	0.0
Fluoranthene	9.7E-03	0.291	<0.1	100.0	0.0	0.0
2-Methylnaphthalene	2.7E-03	0.43	<0.1	100.0	0.0	0.0
Phenanthrene	3.6E-03	1.97	<0.1	100.0	0.0	0.0
Pyrene	1.1E-03	0.174	<0.1	100.0	0.0	0.0
Pesticides and PCBs (mg/kg)						
Aldrin	6.6E-06	0.0371	<0.1	0.0	99.8	0.2
alpha-Chlordane	3.6E-05	0.601	<0.1	89.4	10.6	0.0
gamma-Chlordane	3.6E-05	0.601	<0.1	89.4	10.6	0.0
4,4'-DDD	1.1E-03	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	2.2E-04	0.933	<0.1	14.8	85.2	0.0
Dieldrin	1.8E-05	0.0447	<0.1	100.0	0.0	0.0
Endosulfan I	3.6E-06	5.51	<0.1	100.0	0.0	0.0
Endosulfan II	3.6E-06	5.51	<0.1	99.9	0.1	0.0
Endrin	4.8E-05	0.235	<0.1	19.8	80.2	0.0
Methoxychlor	1.4E-05	62.2	<0.1	98.7	1.3	0.0
Aroclor-1248	8.8E-02	0.42	0.2	4.1	95.9	0.0
Inorganics (mg/kg)						
Aluminum	5.3E-02	44.8	<0.1	100.0	0.0	0.0
Arsenic	1.8E-04	0.673	<0.1	100.0	0.0	0.0
Barium	2.0E-04	7.72	<0.1	100.0	0.0	0.0
Beryllium	6.8E-06	0.0348	<0.1	100.0	0.0	0.0
Cadmium	9.7E-06	1.14	<0.1	100.0	0.0	0.0
Chromium	1.8E-04	0.806	<0.1	100.0	0.0	0.0
Cobalt	8.7E-05	0.769	<0.1	100.0	0.0	0.0

TABLE 7-29 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Copper	3.9E-04	12.3	<0.1	100.0	0.0	0.0
	Iron	6.0E-02	25.9	<0.1	100.0	0.0	0.0
	Lead	1.0E-03	1.46	<0.1	100.0	0.0	0.0
	Manganese	4.9E-03	4.64	<0.1	100.0	0.0	0.0
	Mercury	8.6E-07	0.005	<0.1	100.0	0.0	0.0
	Nickel	2.4E-04	53.3	<0.1	100.0	0.0	0.0
	Selenium	1.3E-05	0.314	<0.1	100.0	0.0	0.0
	Vanadium	2.0E-04	8.94	<0.1	100.0	0.0	0.0
	Zinc	9.1E-04	2.35	<0.1	100.0	0.0	0.0
Wetland 2 Group							
Semivolatile Organics (mg/kg)							
	Acenaphthene	4.7E-03	1.76	<0.1	100.0	0.0	0.0
	Acenaphthylene	4.0E-03	0.205	<0.1	100.0	0.0	0.0
	Anthracene	9.4E-03	174	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	7.2E-02	0.105	0.7	100.0	0.0	0.0
X	Benzo(a)pyrene	3.2E-02	0.0232	1.4	100.0	0.0	0.0
	Benzo(b)fluoranthene	1.1E-01	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	1.3E-03	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	4.5E-03	2.11	<0.1	100.0	0.0	0.0
	Butylbenzylphthalate	3.2E-03	0.838	<0.1	100.0	0.0	0.0
	Carbazole	4.1E-03	0.264	<0.1	100.0	0.0	0.0
	Chrysene	4.5E-02	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	2.5E-04	0.000032	7.9	100.0	0.0	0.0
	Fluoranthene	8.6E-02	0.291	0.3	100.0	0.0	0.0
	Fluorene	5.9E-03	1.76	<0.1	100.0	0.0	0.0
	Indeno(1,2,3-cd)pyrene	3.2E-02	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	2.7E-03	0.43	<0.1	100.0	0.0	0.0
	4-Methylphenol	5.2E-03	1.97	<0.1	100.0	0.0	0.0
	Naphthalene	4.1E-03	0.621	<0.1	100.0	0.0	0.0
	N-Nitrosodiphenylamine	5.4E-04	6.98	<0.1	100.0	0.0	0.0
	Phenanthrene	6.5E-02	1.97	<0.1	100.0	0.0	0.0

TABLE 7-29 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Pyrene	1.1E-01	0.174	0.6	100.0	0.0	0.0
	Pesticides and PCBs (mg/kg)						
	Aldrin	7.1E-06	0.0371	<0.1	0.0	99.8	0.2
	delta-BHC	6.0E-06	0.224	<0.1	99.5	0.5	0.0
	4,4'-DDD	2.7E-03	3.14	<0.1	5.5	94.5	0.0
	4,4'-DDE	5.7E-04	0.933	<0.1	14.8	85.2	0.0
	Dieldrin	3.1E-05	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan II	1.4E-05	5.51	<0.1	99.9	0.1	0.0
	Endosulfan Sulfate	2.7E-06	5.51	<0.1	99.8	0.2	0.0
	Endrin	1.4E-04	0.235	<0.1	19.8	80.2	0.0
	Endrin Aldehyde	5.7E-03	0.235	<0.1	6.0	94.0	0.0
	Endrin Ketone	3.3E-05	0.235	<0.1	19.9	80.1	0.0
	Methoxychlor	4.7E-05	62.2	<0.1	98.7	1.3	0.0
	Aroclor-1248	2.5E-02	0.42	<0.1	4.1	95.9	0.0
	Aroclor-1254	2.1E-02	0.135	0.2	2.7	97.3	0.0
	Inorganics (mg/kg)						
X	Aluminum	5.4E+01	44.8	1.2	100.0	0.0	0.0
X	Antimony	2.8E-01	0.00291	97.7	100.0	0.0	0.0
	Arsenic	7.3E-02	0.673	0.1	100.0	0.0	0.0
	Barium	2.5E+00	7.72	0.3	14.4	85.5	0.1
	Beryllium	6.7E-03	0.0348	0.2	100.0	0.0	0.0
	Cadmium	6.1E-03	1.14	<0.1	100.0	0.0	0.0
	Chromium	1.9E-01	0.806	0.2	98.3	1.6	0.1
	Cobalt	4.4E-02	0.769	<0.1	100.0	0.0	0.0
	Copper	7.3E+00	12.3	0.6	89.3	10.7	0.0
X	Iron	9.6E+01	25.9	3.7	93.8	5.0	1.2
X	Lead	5.6E+00	1.46	3.8	95.7	4.3	0.0
	Manganese	2.2E+00	4.64	0.5	100.0	0.0	0.0
X	Mercury	1.3E+00	0.005	265.1	0.1	99.9	0.0
	Nickel	8.2E-02	53.3	<0.1	100.0	0.0	0.0
	Selenium	1.8E-02	0.314	<0.1	100.0	0.0	0.0

TABLE 7-29 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Silver	5.2E-03	0.469	<0.1	100.0	0.0	0.0
	Vanadium	9.5E-02	8.94	<0.1	100.0	0.0	0.0
X	Zinc	1.6E+01	2.35	6.9	11.1	88.9	0.0
East Middlesex Canal Group							
	Pesticides and PCBs (mg/kg)						
	4,4'-DDD	6.8E-04	3.14	<0.1	5.5	94.5	0.0
	4,4'-DDE	8.8E-05	0.933	<0.1	14.8	85.2	0.0
	Endosulfan I	2.2E-06	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan Sulfate	7.9E-07	5.51	<0.1	99.8	0.2	0.0
	Methoxychlor	2.5E-03	62.2	<0.1	0.0	99.9	0.0
	Inorganics (mg/kg)						
	Arsenic	1.8E-02	0.673	<0.1	100.0	0.0	0.0
	Barium	1.8E-01	7.72	<0.1	100.0	0.0	0.0
	Cobalt	1.8E-02	0.769	<0.1	100.0	0.0	0.0
	Lead	5.6E-01	1.46	0.4	100.0	0.0	0.0
X	Manganese	4.9E+00	4.64	1.0	100.0	0.0	0.0
	Mercury	1.2E-03	0.005	0.2	100.0	0.0	0.0
	Selenium	3.8E-03	0.314	<0.1	100.0	0.0	0.0
	Vanadium	2.9E-02	8.94	<0.1	100.0	0.0	0.0
Richardson Pond Group							
	Semivolatile Organics (mg/kg)						
	Acenaphthene	1.2E-02	1.76	<0.1	100.0	0.0	0.0
	Anthracene	1.1E-02	174	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	3.8E-02	0.105	0.4	100.0	0.0	0.0
X	Benzo(a)pyrene	2.7E-02	0.0232	1.2	100.0	0.0	0.0
	Benzo(b)fluoranthene	3.4E-02	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	1.6E-02	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	2.3E-02	2.11	<0.1	100.0	0.0	0.0
	Butylbenzylphthalate	1.6E-03	0.838	<0.1	100.0	0.0	0.0
	Chrysene	3.6E-02	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	5.3E-03	0.000032	165.9	100.0	0.0	0.0

TABLE 7-29 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
Fluoranthene	5.9E-02	0.291	0.2	100.0	0.0	0.0
Fluorene	1.2E-02	1.76	<0.1	100.0	0.0	0.0
Indeno(1,2,3-cd)pyrene	1.4E-02	3.8	<0.1	100.0	0.0	0.0
2-Methylnaphthalene	3.4E-04	0.43	<0.1	100.0	0.0	0.0
4-Methylphenol	1.3E-03	1.97	<0.1	100.0	0.0	0.0
Naphthalene	1.2E-03	0.621	<0.1	100.0	0.0	0.0
Phenanthrene	5.7E-02	1.97	<0.1	100.0	0.0	0.0
Pyrene	8.6E-02	0.174	0.5	100.0	0.0	0.0
Pesticides and PCBs (mg/kg)						
Aldrin	4.3E-06	0.0371	<0.1	100.0	0.0	0.0
4,4'-DDD	1.2E-03	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	2.4E-04	0.933	<0.1	14.8	85.2	0.0
4,4'-DDT	3.0E-04	0.00318	<0.1	5.7	94.3	0.0
Dieldrin	1.8E-05	0.0447	<0.1	100.0	0.0	0.0
Endosulfan I	6.1E-06	5.51	<0.1	100.0	0.0	0.0
Endosulfan II	9.0E-07	5.51	<0.1	99.9	0.1	0.0
Endosulfan Sulfate	3.2E-06	5.51	<0.1	99.8	0.2	0.0
Endrin	1.3E-04	0.235	<0.1	19.8	80.2	0.0
Methoxychlor	2.2E-05	62.2	<0.1	98.7	1.3	0.0
Inorganics (mg/kg)						
X Aluminum	4.7E+01	44.8	1.1	100.0	0.0	0.0
Arsenic	4.8E-02	0.673	<0.1	100.0	0.0	0.0
Barium	6.1E+00	7.72	0.8	8.4	91.4	0.2
Beryllium	5.8E-03	0.0348	0.2	100.0	0.0	0.0
Cadmium	2.3E-03	1.14	<0.1	100.0	0.0	0.0
Chromium	1.2E-01	0.806	0.1	100.0	0.0	0.0
Cobalt	3.7E-02	0.769	<0.1	98.0	1.6	0.4
Copper	3.5E-01	12.3	<0.1	100.0	0.0	0.0
X Iron	1.0E+02	25.9	4.0	85.3	11.8	2.9
Lead	1.3E+00	1.46	0.9	56.2	43.6	0.2
Manganese	2.1E+00	4.64	0.5	100.0	0.0	0.0

TABLE 7-29 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
X	Mercury	1.2E-01	0.005	24.0	2.0	98.0	0.0
	Nickel	2.2E-01	53.3	<0.1	38.2	61.6	0.1
	Selenium	3.2E-03	0.314	<0.1	100.0	0.0	0.0
	Silver	4.1E-03	0.469	<0.1	100.0	0.0	0.0
	Vanadium	1.4E-01	8.94	<0.1	100.0	0.0	0.0
X	Zinc	1.8E+01	2.35	7.7	6.7	93.3	0.0
Content Brook Wetland Group							
	Semivolatile Organics (mg/kg)						
	Acenaphthene	2.9E-04	1.76	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	2.3E-03	0.105	<0.1	100.0	0.0	0.0
	Benzo(a)pyrene	2.0E-03	0.0232	<0.1	100.0	0.0	0.0
	Benzo(b)fluoranthene	2.5E-03	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	8.5E-04	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	2.3E-03	2.11	<0.1	100.0	0.0	0.0
	Carbazole	4.9E-04	0.264	<0.1	100.0	0.0	0.0
	Chrysene	2.7E-03	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	5.6E-04	0.000032	17.4	100.0	0.0	0.0
	Fluoranthene	5.9E-03	0.291	<0.1	100.0	0.0	0.0
	Fluorene	1.4E-03	1.76	<0.1	100.0	0.0	0.0
	Indeno(1,2,3-cd)pyrene	1.1E-03	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	2.3E-04	0.43	<0.1	100.0	0.0	0.0
	Naphthalene	8.1E-04	0.621	<0.1	100.0	0.0	0.0
	Phenanthrene	4.9E-03	1.97	<0.1	100.0	0.0	0.0
	Pyrene	5.6E-03	0.174	<0.1	99.6	0.0	0.4
	Pesticides and PCBs (mg/kg)						
	Aldrin	1.4E-04	0.0371	<0.1	0.0	99.8	0.2
	4,4'-DDD	3.2E-05	3.14	<0.1	93.0	7.0	0.0
	4,4'-DDE	1.2E-05	0.933	<0.1	97.5	2.5	0.0
	gamma-Chlordane	4.3E-03	0.601	<0.1	0.0	100.0	0.0
	Dieldrin	4.9E-06	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan I	7.0E-07	5.51	<0.1	100.0	0.0	0.0

TABLE 7-29 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT HIGH FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Endosulfan II	1.7E-05	5.51	<0.1	99.9	0.1	0.0
	Endosulfan Sulfate	5.4E-07	5.51	<0.1	99.8	0.2	0.0
	Heptachlor Epoxide	5.9E-07	0.572	<0.1	100.0	0.0	0.0
	Methoxychlor	2.6E-05	62.2	<0.1	98.7	1.3	0.0
Inorganics (mg/kg)							
X	Aluminum	1.4E+03	44.8	31.5	4.1	95.8	0.1
X	Arsenic	2.1E+01	0.673	30.7	2.2	96.4	1.4
X	Barium	1.4E+02	7.72	18.1	0.3	99.5	0.2
	Chromium	1.4E-01	0.806	0.2	72.3	25.5	2.1
	Cobalt	3.8E-02	0.769	<0.1	84.6	12.3	3.1
	Copper	3.2E+00	12.3	0.3	2.8	97.2	0.1
X	Iron	2.8E+02	25.9	10.9	48.6	41.1	10.3
	Lead	1.0E+00	1.46	0.7	17.4	82.2	0.5
X	Manganese	1.1E+02	4.64	22.9	3.5	96.2	0.3
	Nickel	1.2E+00	53.3	<0.1	5.9	93.9	0.2
X	Selenium	1.2E+00	0.314	3.7	0.4	99.6	0.1
X	Silver	7.4E-01	0.469	1.6	1.6	98.2	0.2
	Vanadium	1.6E-01	0.469	0.3	84.8	12.2	3.0
X	Zinc	4.6E+01	0.469	98.7	0.4	99.5	0.0

HQ = Hazard quotient.

X = Indicates a COPC with a HQ >=1.

TABLE 7-30. COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
West Middlesex Canal Group						
Semivolatile Organics (mg/kg)						
Benzo(a)anthracene	4.7E-03	0.105	<0.1	100.0	0.0	0.0
Benzo(b)fluoranthene	6.5E-03	2.11	<0.1	100.0	0.0	0.0
Benzo(k)fluoranthene	5.4E-03	2.11	<0.1	100.0	0.0	0.0
Butylbenzylphthalate	6.3E-04	0.838	<0.1	100.0	0.0	0.0
Chrysene	6.5E-03	5.22	<0.1	100.0	0.0	0.0
Fluoranthene	9.7E-03	0.291	<0.1	100.0	0.0	0.0
2-Methylnaphthalene	2.7E-03	0.43	<0.1	100.0	0.0	0.0
Phenanthrene	3.6E-03	1.97	<0.1	100.0	0.0	0.0
Pyrene	1.1E-03	0.174	<0.1	100.0	0.0	0.0
Pesticides and PCBs (mg/kg)						
alpha-Chlordane	3.6E-05	0.601	<0.1	89.4	10.6	0.0
gamma-Chlordane	3.6E-05	0.601	<0.1	89.4	10.6	0.0
4,4'-DDD	1.1E-03	3.14	<0.1	5.5	94.5	0.0
4,4'-DDE	2.2E-04	0.933	<0.1	14.8	85.2	0.0
Dieldrin	1.8E-05	0.0447	<0.1	100.0	0.0	0.0
Endosulfan I	3.6E-06	5.51	<0.1	100.0	0.0	0.0
Endosulfan II	3.6E-06	5.51	<0.1	99.9	0.1	0.0
Endrin	4.8E-05	0.235	<0.1	19.8	80.2	0.0
Methoxychlor	1.4E-05	62.2	<0.1	98.7	1.3	0.0
Aroclor-1248	8.8E-02	0.42	0.2	4.1	95.9	0.0
Inorganics (mg/kg)						
Aluminum	5.3E-02	44.8	<0.1	100.0	0.0	0.0
Arsenic	1.8E-04	0.673	<0.1	100.0	0.0	0.0
Barium	2.0E-04	7.72	<0.1	100.0	0.0	0.0
Beryllium	6.8E-06	0.0348	<0.1	100.0	0.0	0.0
Cadmium	9.7E-06	1.14	<0.1	100.0	0.0	0.0
Chromium	1.8E-04	0.806	<0.1	100.0	0.0	0.0
Cobalt	8.7E-05	0.769	<0.1	100.0	0.0	0.0
Copper	3.9E-04	12.3	<0.1	100.0	0.0	0.0

TABLE 7-30 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

	COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Iron	6.0E-02	25.9	<0.1	100.0	0.0	0.0
	Lead	1.0E-03	1.46	<0.1	100.0	0.0	0.0
	Manganese	4.9E-03	4.64	<0.1	100.0	0.0	0.0
	Mercury	8.6E-07	0.005	<0.1	100.0	0.0	0.0
	Nickel	2.4E-04	53.3	<0.1	100.0	0.0	0.0
	Selenium	1.3E-05	0.314	<0.1	100.0	0.0	0.0
	Vanadium	2.0E-04	8.94	<0.1	100.0	0.0	0.0
	Zinc	9.1E-04	2.35	<0.1	100.0	0.0	0.0
Wetland 2 Group							
	Semivolatile Organics (mg/kg)						
	Acenaphthene	4.7E-03	1.76	<0.1	100.0	0.0	0.0
	Acenaphthylene	4.0E-03	0.205	<0.1	100.0	0.0	0.0
	Anthracene	9.4E-03	174	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	7.2E-02	0.105	0.7	100.0	0.0	0.0
X	Benzo(a)pyrene	3.2E-02	0.0232	1.4	100.0	0.0	0.0
	Benzo(b)fluoranthene	1.1E-01	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	1.3E-03	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	4.5E-03	2.11	<0.1	100.0	0.0	0.0
	Butylbenzylphthalate	3.2E-03	0.838	<0.1	100.0	0.0	0.0
	Carbazole	4.1E-03	0.264	<0.1	100.0	0.0	0.0
	Chrysene	4.5E-02	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	2.5E-04	0.000032	7.9	100.0	0.0	0.0
	Fluoranthene	8.6E-02	0.291	0.3	100.0	0.0	0.0
	Fluorene	5.9E-03	1.76	<0.1	100.0	0.0	0.0
	Indeno(1,2,3-cd)pyrene	3.2E-02	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	2.7E-03	0.43	<0.1	100.0	0.0	0.0
	4-Methylphenol	5.2E-03	1.97	<0.1	100.0	0.0	0.0
	Naphthalene	4.1E-03	0.621	<0.1	100.0	0.0	0.0
	N-Nitrosodiphenylamine	5.4E-04	6.98	<0.1	100.0	0.0	0.0
	Phenanthrene	6.5E-02	1.97	<0.1	100.0	0.0	0.0
	Pyrene	1.1E-01	0.174	0.6	100.0	0.0	0.0

TABLE 7-30 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

	COPC	Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Pesticides and PCBs (mg/kg)						
	delta-BHC	6.0E-06	0.224	<0.1	99.5	0.5	0.0
	4,4'-DDD	2.7E-03	3.14	<0.1	5.5	94.5	0.0
	4,4'-DDE	5.7E-04	0.933	<0.1	14.8	85.2	0.0
	Dieldrin	3.1E-05	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan II	1.4E-05	5.51	<0.1	99.9	0.1	0.0
	Endosulfan Sulfate	2.7E-06	5.51	<0.1	99.8	0.2	0.0
	Endrin	1.4E-04	0.235	<0.1	19.8	80.2	0.0
	Endrin Aldehyde	5.7E-03	0.235	<0.1	6.0	94.0	0.0
	Endrin Ketone	3.3E-05	0.235	<0.1	19.9	80.1	0.0
	Methoxychlor	4.7E-05	62.2	<0.1	98.7	1.3	0.0
	Aroclor-1248	2.5E-02	0.42	<0.1	4.1	95.9	0.0
	Aroclor-1254	2.1E-02	0.135	0.2	2.7	97.3	0.0
	Inorganics (mg/kg)						
X	Aluminum	5.4E+01	44.8	1.2	100.0	0.0	0.0
X	Antimony	2.8E-01	0.00291	97.7	100.0	0.0	0.0
	Arsenic	7.3E-02	0.673	0.1	100.0	0.0	0.0
X	Barium	1.2E+01	7.72	1.5	3.0	96.8	0.2
	Beryllium	6.7E-03	0.0348	0.2	100.0	0.0	0.0
	Cadmium	6.1E-03	1.14	<0.1	100.0	0.0	0.0
	Chromium	2.0E-01	0.806	0.3	94.6	4.9	0.4
	Cobalt	4.4E-02	0.769	<0.1	100.0	0.0	0.0
X	Copper	2.3E+01	12.3	1.9	28.1	71.9	0.1
X	Iron	1.0E+02	25.9	3.9	89.9	8.1	2.0
X	Lead	7.9E+00	1.46	5.4	67.6	32.2	0.2
	Manganese	2.2E+00	4.64	0.5	100.0	0.0	0.0
	Mercury	1.7E-03	0.005	0.3	100.0	0.0	0.0
	Nickel	3.2E+00	53.3	<0.1	2.6	97.2	0.2
	Selenium	1.8E-02	0.314	<0.1	100.0	0.0	0.0
	Silver	9.3E-02	0.469	0.2	5.6	94.2	0.2
	Vanadium	9.9E-02	8.94	<0.1	95.6	3.5	0.9

TABLE 7-30 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
X	Zinc	4.5E+02	2.35	189.5	0.4	99.6	0.0
East Middlesex Canal Group							
	Pesticides and PCBs (mg/kg)						
	4,4'-DDD	6.8E-04	3.14	<0.1	5.5	94.5	0.0
	4,4'-DDE	8.8E-05	0.933	<0.1	14.8	85.2	0.0
	Endosulfan I	2.2E-06	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan Sulfate	7.9E-07	5.51	<0.1	99.8	0.2	0.0
	Methoxychlor	7.7E-07	62.2	<0.1	98.7	1.3	0.0
	Inorganics (mg/kg)						
	Arsenic	1.8E-02	0.673	<0.1	100.0	0.0	0.0
	Barium	1.8E-01	7.72	<0.1	100.0	0.0	0.0
	Cobalt	1.8E-02	0.769	<0.1	100.0	0.0	0.0
	Lead	5.6E-01	1.46	0.4	100.0	0.0	0.0
X	Manganese	4.9E+00	4.64	1.0	100.0	0.0	0.0
	Mercury	1.2E-03	0.005	0.2	100.0	0.0	0.0
	Selenium	3.8E-03	0.314	<0.1	100.0	0.0	0.0
	Vanadium	2.9E-02	8.94	<0.1	100.0	0.0	0.0
Richardson Pond Group							
	Semivolatile Organics (mg/kg)						
	Acenaphthene	1.2E-02	1.76	<0.1	100.0	0.0	0.0
	Anthracene	1.1E-02	174	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	3.8E-02	0.105	0.4	100.0	0.0	0.0
X	Benzo(a)pyrene	2.7E-02	0.0232	1.2	100.0	0.0	0.0
	Benzo(b)fluoranthene	3.4E-02	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	1.6E-02	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	2.3E-02	2.11	<0.1	100.0	0.0	0.0
	Butylbenzylphthalate	1.6E-03	0.838	<0.1	100.0	0.0	0.0
	Chrysene	3.6E-02	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	5.3E-03	0.000032	165.9	100.0	0.0	0.0
	Fluoranthene	5.9E-02	0.291	0.2	100.0	0.0	0.0
	Fluorene	1.2E-02	1.76	<0.1	100.0	0.0	0.0

TABLE 7-30 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Indeno(1,2,3-cd)pyrene	1.4E-02	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	3.4E-04	0.43	<0.1	100.0	0.0	0.0
	4-Methylphenol	1.3E-03	1.97	<0.1	100.0	0.0	0.0
	Naphthalene	1.2E-03	0.621	<0.1	100.0	0.0	0.0
	Phenanthrene	5.7E-02	1.97	<0.1	100.0	0.0	0.0
	Pyrene	8.6E-02	0.174	0.5	99.9	0.0	0.1
	Pesticides and PCBs (mg/kg)						
	Aldrin	4.3E-06	0.0371	<0.1	100.0	0.0	0.0
	4,4'-DDD	9.2E-02	3.14	<0.1	0.1	99.9	0.0
	4,4'-DDE	2.4E-04	0.933	<0.1	14.8	85.2	0.0
	4,4'-DDT	3.0E-04	0.00318	<0.1	5.7	94.3	0.0
	Dieldrin	1.8E-05	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan I	6.1E-06	5.51	<0.1	100.0	0.0	0.0
	Endosulfan II	9.0E-07	5.51	<0.1	99.9	0.1	0.0
	Endosulfan Sulfate	3.2E-06	5.51	<0.1	99.8	0.2	0.0
	Endrin	1.3E-04	0.235	<0.1	19.8	80.2	0.0
	Methoxychlor	2.2E-05	62.2	<0.1	98.7	1.3	0.0
	Inorganics (mg/kg)						
X	Aluminum	9.2E+02	44.8	20.4	5.2	94.7	0.1
	Arsenic	4.8E-02	0.673	<0.1	100.0	0.0	0.0
X	Barium	1.1E+01	7.72	1.5	4.5	95.3	0.2
	Beryllium	5.8E-03	0.0348	0.2	100.0	0.0	0.0
	Cadmium	2.3E-03	1.14	<0.1	100.0	0.0	0.0
	Chromium	1.4E-01	0.806	0.2	81.2	17.4	1.4
	Cobalt	3.6E-02	0.769	<0.1	100.0	0.0	0.0
	Copper	8.2E+00	12.3	0.7	4.3	95.6	0.1
X	Iron	1.0E+02	25.9	3.9	87.2	10.2	2.6
X	Lead	2.8E+00	1.46	1.9	25.5	74.1	0.4
	Manganese	2.1E+00	4.64	0.5	100.0	0.0	0.0
	Mercury	2.3E-03	0.005	0.5	100.0	0.0	0.0
	Nickel	8.4E-02	53.3	<0.1	100.0	0.0	0.0

TABLE 7-30 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Selenium	2.6E-01	0.314	0.8	1.2	98.7	0.1
	Silver	1.3E-01	0.469	0.3	3.2	96.6	0.2
	Vanadium	1.5E-01	8.94	<0.1	92.3	6.2	1.5
X	Zinc	2.4E+02	2.35	103.4	0.5	99.5	0.0
Content Brook Wetland Group							
Semivolatile Organics (mg/kg)							
	Acenaphthene	2.9E-04	1.76	<0.1	100.0	0.0	0.0
	Benzo(a)anthracene	2.3E-03	0.105	<0.1	100.0	0.0	0.0
	Benzo(a)pyrene	2.0E-03	0.0232	<0.1	100.0	0.0	0.0
	Benzo(b)fluoranthene	2.5E-03	2.11	<0.1	100.0	0.0	0.0
	Benzo(g,h,i)perylene	8.5E-04	3.8	<0.1	100.0	0.0	0.0
	Benzo(k)fluoranthene	2.3E-03	2.11	<0.1	100.0	0.0	0.0
	Carbazole	4.9E-04	0.264	<0.1	100.0	0.0	0.0
	Chrysene	2.7E-03	5.22	<0.1	100.0	0.0	0.0
X	Dibenzo(a,h)anthracene	5.6E-04	0.000032	17.4	100.0	0.0	0.0
	Fluoranthene	5.9E-03	0.291	<0.1	100.0	0.0	0.0
	Fluorene	1.4E-03	1.76	<0.1	100.0	0.0	0.0
	Indeno(1,2,3-cd)pyrene	1.1E-03	3.8	<0.1	100.0	0.0	0.0
	2-Methylnaphthalene	2.3E-04	0.43	<0.1	100.0	0.0	0.0
	Naphthalene	8.1E-04	0.621	<0.1	100.0	0.0	0.0
	Phenanthrene	4.9E-03	1.97	<0.1	100.0	0.0	0.0
	Pyrene	5.6E-03	0.174	<0.1	100.0	0.0	0.0
Pesticides and PCBs (mg/kg)							
	alpha-Chlordane	4.8E-03	0.601	<0.1	0.0	100.0	0.0
	4,4'-DDD	3.2E-05	3.14	<0.1	93.0	7.0	0.0
	4,4'-DDE	1.2E-05	0.933	<0.1	97.5	2.5	0.0
	Dieldrin	4.9E-06	0.0447	<0.1	100.0	0.0	0.0
	Endosulfan I	7.0E-07	5.51	<0.1	100.0	0.0	0.0
	Endosulfan II	1.7E-05	5.51	<0.1	99.9	0.1	0.0
	Endosulfan Sulfate	5.4E-07	5.51	<0.1	99.8	0.2	0.0
	Heptachlor Epoxide	5.9E-07	0.572	<0.1	100.0	0.0	0.0

TABLE 7-30 (Continued). COMPARISON OF MAXIMUM DIETARY DOSES FOR GREAT BLUE HERON AT LOW FLOW CONDITIONS

COPC		Total Dose (mg/kg day)	TRV (mg/kg day)	Total HQ	Percent Sediment HQ	Percent Fish HQ	Percent Surface Water HQ
	Methoxychlor	2.6E-05	62.2	<0.1	98.7	1.3	0.0
	Inorganics (mg/kg)						
X	Aluminum	3.2E+02	44.8	7.1	18.3	81.6	0.1
X	Arsenic	1.5E+00	0.673	2.2	30.5	68.5	1.0
X	Barium	8.5E+00	7.72	1.1	5.4	94.5	0.2
	Chromium	1.1E-01	0.806	0.1	93.7	5.8	0.5
	Cobalt	3.2E-02	0.769	<0.1	100.0	0.0	0.0
	Copper	9.2E-01	12.3	<0.1	9.7	90.3	0.1
X	Iron	1.5E+02	25.9	5.6	94.1	4.8	1.2
X	Lead	2.4E+00	1.46	1.7	7.5	92.0	0.5
	Manganese	3.7E+00	4.64	0.8	100.0	0.0	0.0
	Nickel	7.1E-02	53.3	<0.1	100.0	0.0	0.0
	Selenium	4.5E-03	0.314	<0.1	100.0	0.0	0.0
	Silver	1.2E-02	0.469	<0.1	100.0	0.0	0.0
	Vanadium	1.4E-01	8.94	<0.1	97.6	1.9	0.5
	Zinc	2.1E-01	2.35	<0.1	100.0	0.0	0.0

HQ = Hazard quotient.

X = Indicates a COPC with a HQ >=1.

TABLE 7-31. CALCULATION OF BODY SIZE SCALING FACTORS FOR EXTRAPOLATING TOXICOLOGICAL DATA FOR WILDLIFE RECEPTORS

Test Species	Mean Wet Body Weight (kg)	Reference	Receptor Species	Mean Wet Body Weight (kg)	Reference	Scaling Factor (1)
Mouse	0.03	USEPA (1988d)	Short-tailed shrew	0.015	USEPA (1993f)	1.26
Rat	0.35	USEPA (1988d)	Short-tailed shrew	0.015	USEPA (1993f)	2.86
Red-winged blackbird	0.053	Dunning (1984)	Short-tailed shrew	0.015	USEPA (1993f)	1.52
Domestic rabbit	2.8	USEPA (1988d)	Short-tailed shrew	0.015	USEPA (1993f)	5.72
Mink	1.0	USEPA (1993f)	Short-tailed shrew	0.015	USEPA (1993f)	4.05
Red-winged blackbird	0.053	Dunning (1984)	Great blue heron	2.39	Dunning (1984)	0.28
Mouse	0.03	USEPA (1988d)	Great blue heron	2.39	Dunning (1984)	0.23
Rat	0.35	USEPA (1988d)	Great blue heron	2.39	Dunning (1984)	0.53
Ring dove	0.155	Carriere et al. (1986)	Great blue heron	2.39	Dunning (1984)	0.405
Brown-headed cowbird	0.049	Dunning (1984)	Great blue heron	2.39	Dunning (1984)	0.274
Chicken (chicks)	0.121	Johnson et al. (1960)	Great blue heron	2.39	Dunning (1984)	0.370
Mallard	1.153	White and Finley (1978)	Great blue heron	2.39	Dunning (1984)	0.784
Black duck	1.25	Dunning (1984)	Great blue heron	2.39	Dunning (1984)	0.807
American kestrel	0.130	Pattee (1984)	Great blue heron	2.39	Dunning (1984)	0.379
Mallard (duckling)	0.782	Cain and Pafford (1981)	Great blue heron	2.39	Dunning (1984)	0.689
Ring-necked pheasant	1.0	USEPA (1993f)	Great blue heron	2.39	Dunning (1984)	0.748
Japanese quail (chick)	0.017	USEPA (1993f)	Great blue heron	2.39	Dunning (1984)	0.192
Japanese quail	0.15	Vos et al. (1971)	Great blue heron	2.39	Dunning (1984)	0.397
Brown pelican	3.5	Dunning (1984)	Great blue heron	2.39	Dunning (1984)	1.14
Barn owl	0.466	Johnsgard (1988)	Great blue heron	2.39	Dunning (1984)	0.580

TABLE 7-31 (Continued). CALCULATION OF BODY SIZE SCALING FACTORS FOR EXTRAPOLATING TOXICOLOGICAL DATA FOR WILDLIFE RECEPTORS

Test Species	Mean Wet Body Weight (kg)	Reference	Receptor Species	Mean Wet Body Weight (kg)	Reference	Scaling Factor (1)
Gray partridge	0.4	Abiola (1992)	Great blue heron	2.39	Dunning (1984)	0.551
Chicken	1.5	USEPA (1988d)	Great blue heron	2.39	Dunning (1984)	0.86

NOTES:
1. The body size scaling factor is calculated as described in section 7.3.1.2.

TABLE 7-32. DERIVATION OF REFERENCE TOXICITY DOSES OF COPC IN SURFACE SOIL AND SURFACE WATER FOR THE SHORT-TAILED SHREW

Constituent	Organism	Endpoint	Daily Dose (mg/kg-day)	Reference	Total Uncertainty Factor	Chronic NOAEL - Test Organism (mg/kg-day)	Body Weight Scaling Factor	Reference Toxicity Dose - Short-tailed Shrew (mg/kg-day)
Acenaphthene	Mouse	subchronic NOAEL	175	USEPA (1989d)	0.1	17.5	1.26	22.0
Acenaphthylene	Mouse	subchronic LD_{50}	1760	RTECS (1995)	0.005	8.80	1.26	11.1
Benzo(a)anthracene	Rat	chronic NOAEL	2.0	Eisler (1987)	1	2.0	2.86	5.72
Benzo(a)pyrene	Mouse	chronic LOAEL	10	Eisler (1987)	0.1	1.0	1.26	1.26
Benzo(b)fluoranthene	Rat	chronic NOAEL	40	Eisler (1987)	1	40	2.86	114
Benzo(g,h,i)perylene[(1)]	Rat	chronic NOAEL	72	Eisler (1987) USEPA (1993d) ATSDR (1990)	1	72	2.86	206
Butylbenzylphthalate	Rat	subchronic NOAEL	159	USEPA (1989c)	0.1	15.9	2.86	45.4
Carbazole	Rat	subchronic LOAEL	500	RTECS (1995)	0.01	5	2.86	14.3
Chrysene	Rat	chronic NOAEL	99	Eisler (1987)	1	99	2.86	283
Dibenz(a,h)anthracene	Rat	chronic LOAEL	0.006	Eisler (1987)	0.1	0.0006	2.86	0.00172
Dibenzofuran	Red-winged blackbird	subchronic NOAEL	63.2	Schaefer et al. (1983) Dunning (1984) USEPA (1988d)	0.1	6.32	1.52	9.63
Fluoranthene	Mouse	subchronic NOAEL	125	USEPA (1988c)	0.1	12.5	1.26	15.8
Indeno(1,2,3-cd)pyrene	Rat	chronic NOAEL	72	Eisler (1987)	1	72	2.86	206
2-Methylnaphthalene	Rat	subchronic LD_{50}	1630	RTECS (1995)	0.005	8.15	2.86	23.3
Phenanthrene	Red-winged blackbird	subchronic NOAEL	70	Schafer et al. (1983) Dunning (1984) USEPA (1988d)	0.1	7.0	1.52	10.7
Pyrene	Mouse	subchronic NOAEL	75	USEPA (1989e)	0.1	7.5	1.26	9.45
Aldrin	Rat	chronic NOAEL	0.20	Opresko et al. (1994)	1	0.2	2.86	0.252
4,4'-DDT	Rat	chronic NOAEL	0.8	Opresko et al. (1994)	1	0.8	2.86	2.29
Endrin	Mouse	chronic LOAEL	0.92	Opresko et al. (1994)	0.1	0.092	1.26	0.116
Endrin aldehyde	Mouse	chronic LOAEL	0.92	Opresko et al. (1994)	0.1	0.092	1.26	0.116
Endrin ketone	Mouse	chronic LOAEL	0.92	Opresko et al. (1994)	0.1	0.092	1.26	0.116
Methoxychlor	Rat	chronic NOAEL	4	Opresko et al. (1994)	1	4	2.86	11.4
Antimony	Mouse	chronic LOAEL	1.25	Opresko et al. (1994)	0.1	0.125	1.26	0.157

TABLE 3-32 (Continued). DERIVATION OF REFERENCE TOXICITY DOSES OF THE COPC IN SURFACE SOIL AND SURFACE WATER FOR THE SHORT-TAILED SHREW

Constituent	Organism	Endpoint	Daily Dose (mg/kg-day)	Reference	Total Uncertainty Factor	Chronic NOAEL - Test Organism (mg/kg-day)	Body Weight Scaling Factor	Reference Toxicity Dose - Short-tailed Shrew (mg/kg-day)
Barium	Rat	chronic NOAEL	5.06	Opresko et al. (1994)	1	5.06	2.86	14.5
Cadmium	Mouse	chronic LOAEL	1.913	Opresko et al. (1994)	0.1	0.1913	1.26	0.241
Chromium	Rat	chronic NOAEL	2,737	Opresko et al. (1994)	1	2,737	2.86	7820
Copper	Mink	chronic NOAEL	11.71	Opresko et al. (1994)	1	11.71	4.05	47.5
Cyanide	Rat	chronic LOAEL	68.7	Opresko et al. (1994)	0.1	6.87	2.86	19.6
Iron	Mouse	subchronic LD_{50}	306	NAS (1980)	0.005	1.53	1.26	1.93
Lead	Rat	chronic NOAEL	8	Opresko et al. (1994)	1	8	2.86	22.9
Mercury	Rat	chronic NOAEL	0.032	Opresko et al. (1994)	1	0.032	2.86	0.0914
Nickel	Rat	chronic NOAEL	40	Opresko et al. (1994)	1	40	2.86	114
Silver	Rat	chronic LOAEL	89	Olcott (1950)	0.1	8.9	2.86	25.4
Vanadium	Rat	chronic LOAEL	2.1	Opresko et al. (1994)	0.1	0.21	2.86	0.600
Zinc	Rat	chronic NOAEL	160	Opresko et al. (1994)	1	160	2.86	457

1. In the absence of a toxicity study for benzo (g,h,i) perylene, data from a study on indeno (1,2,3-cd)pyrene was used to derive a reference toxicity value for benzo(g,h,i)perylene.

TABLE 7-33. DERIVATION OF REFERENCE TOXICITY DOSES OF THE COPC IN SEDIMENTS AND SURFACE WATER FOR THE GREAT BLUE HERON

Analyte	Test Organism	Endpoint	Daily Dose (mg/kg-day)	Reference	Total Uncertainty Factor (1)	Chronic NOAEL - Test Organism mg/kg-day	Body Weight Scaling Factor	Reference Toxicity Dose - Great Blue Heron (mg/kg-day)
Acenaphthene	Red-winged blackbird	subchronic NOAEL	62.5	Schafer et al. (1983) Dunning (1984) USEPA (1988d)	0.1	6.25	0.281	1.76
Acenaphthylene	Mouse	subchronic LD_{50}	1760	RTECS (1995)	0.0005	0.88	0.232	0.205
Anthracene	Rat	chronic NOAEL	3300	Eisler (1987)	0.1	330	0.527	174
Benzo(a)anthracene	Rat	chronic NOAEL	2.0	Eisler (1987)	0.1	0.20	0.527	0.105
Benzo(a)pyrene	Mouse	chronic LOAEL	10	Opresko et al. (1994)	0.01	0.10	0.232	0.0232
Benzo(b & k)fluoranthene	Rat	chronic NOAEL	40	Eisler (1987)	0.1	4.0	0.527	2.11
Benzo(g,h,i)perylene	Rat	chronic NOAEL	72	Eisler (1987) USEPA (1993d) ATSDR (1990)	0.1	7.2	0.527	3.80
Butylbenzylphthalate	Rat	subchronic NOAEL	159	USEPA (1989c)	0.01	1.59	0.527	0.838
Carbazole	Rat	subchronic LOAEL	500	RTECS (1995)	0.001	0.5	0.527	0.264
Chrysene	Rat	chronic NOAEL	99	Eisler (1987)	0.1	9.9	0.527	5.22
Dibenzo(a,h)anthracene	Rat	chronic LOAEL	0.006	Eisler (1987)	0.01	0.00006	0.527	0.000032
Fluoranthene	Mouse	subchronic NOAEL	125	USEPA (1988c)	0.01	1.25	0.232	0.291
Fluorene	Red-winged blackbird	subchronic NOAEL	62.5	Schafer et al. (1983) Dunning (1984) USEPA (1988d)	0.1	6.25	0.281	1.76
Indeno(1,2,3-cd)pyrene	Rat	chronic NOAEL	72	Eisler (1987)	0.1	7.2	0.527	3.80
2-Methylnaphthalene	Rat	subchronic LD_{50}	1630	RTECS (1995)	0.0005	0.815	0.527	0.430
4-Methylphenol	Red-winged blackbird	subchronic NOAEL	70	Schafer et al. (1983) Dunning (1984) USEPA (1988d)	0.1	7.0	0.281	1.97
Naphthalene	Mouse	subchronic NOAEL	267	USEPA (1990)	0.01	2.67	0.232	0.621
N-Nitrosodiphenylamine	Mouse	chronic NOAEL	301	ATSDR (1992)	0.1	30.1	0.232	6.98
Phenanthrene	Red-winged blackbird	subchronic NOAEL	70	Schafer et al. (1983) Dunning (1984) USEPA (1988d)	0.1	7.0	0.281	1.97
Pyrene	Mouse	subchronic NOAEL	75	USEPA (1989e)	0.01	0.75	0.232	0.174

TABLE 7-33 (Continued). DERIVATION OF REFERENCE TOXICITY DOSES OF THE COPC IN SEDIMENTS AND SURFACE WATER FOR THE GREAT BLUE HERON

Analyte	Test Organism	Endpoint	Daily Dose (mg/kg-day)	Reference	Total Uncertainty Factor (1)	Chronic NOAEL - Test Organism mg/kg-day	Body Weight Scaling Factor	Reference Toxicity Dose - Great Blue Heron (mg/kg-day)
Aroclor 1248	Chicken	NOAEL	0.49	USEPA (1993d,f)	1	0.49	0.86	0.42
Aroclor 1254	Ring-necked pheasant	chronic LOAEL	1.8	Opresko et al. (1994)	0.1	0.18	0.748	0.135
Aldrin	Japanese quail (chick)	subchronic LOAEL	19.3	Hill and Camardese (1986) USEPA (1993f)	0.01	0.193	0.192	0.0371
δ-BHC	Japanese quail	chronic NOAEL	0.563	Opresko et al. (1986)	1	0.563	0.397	0.224
α and γ-Chlordane	Red-winged blackbird	chronic NOAEL	2.14	Opresko et al. (1994)	1	2.14	0.281	0.601
4,4'-DDD	Mallard	chronic NOAEL	4.0	Heath et al. (1969)	1	4.0	0.784	3.14
4,4'-DDE	Japanese quail (chick)	subchronic LOAEL	485	Hill and Camardese (1986) USEPA (1993f)	0.01	4.85	0.192	0.933
4,4'-DDT	Brown pelican	chronic LOAEL	0.0028	Opresko et al. (1994)	0.1	0.00028	1.14	0.000318
Dieldrin	Barn owl	chronic NOAEL	0.077	Opresko et al. (1994)	1	0.077	0.580	0.0447
Endosulfan I	Gray partridge	chronic NOAEL	10	Opresko et al. (1994)	1	10	0.551	5.51
Endosulfan II	Gray partridge	chronic NOAEL	10	Opresko et al. (1994)	1	10	0.551	5.51
Endosulfan sulfate	Gray partridge	chronic NOAEL	10	Opresko et al. (1994)	1	10	0.551	5.51
Endrin	Mallard	chronic NOAEL	0.30	Opresko et al. (1994)	1	0.30	0.784	0.235
Endrin aldehyde	Mallard	chronic NOAEL	0.30	Opresko et al. (1994)	1	0.30	0.784	0.235
Endrin ketone	Mallard	chronic NOAEL	0.30	Opresko et al. (1994)	1	0.30	0.784	0.235
Heptachlor epoxide	Japanese quail (chick)	subchronic NOAEL	29.8	Hill and Camardese (1986) USEPA (1993f)	0.1	2.98	0.192	0.572
Methoxychlor	Japanese quail (chick)	subchronic NOAEL	3235	Hill and Camardese (1986) USEPA (1993f)	0.1	323.5	0.192	62.2
Aluminum	Ringed dove	chronic NOAEL	111.4	Opresko et al. (1994)	1	111.4	0.402	44.8
Antimony	Mouse	chronic LOAEL	1.25	Opresko et al. (1994)	0.01	0.0125	0.232	0.00291
Arsenic	Brown-headed cowbird	chronic NOAEL	2.46	Opresko et al. (1994)	1	2.46	0.274	0.673
Barium	Chicken (chicks)	subchronic NOAEL	208.6	Opresko et al. (1994)	0.1	20.86	0.370	7.72
Beryllium	Rat	chronic NOAEL	0.66	Opresko et al. (1994)	0.1	0.066	0.527	0.0348
Cadmium	Mallard	chronic NOAEL	1.45	Opresko et al. (1994)	1	1.45	0.784	1.14

TABLE 7-33 (Continued). DERIVATION OF REFERENCE TOXICITY DOSES OF THE COPC IN SEDIMENTS AND SURFACE WATER FOR THE GREAT BLUE HERON

Analyte	Test Organism	Endpoint	Daily Dose (mg/kg-day)	Reference	Total Uncertainty Factor (1)	Chronic NOAEL - Test Organism mg/kg-day	Body Weight Scaling Factor	Reference Toxicity Dose - Great Blue Heron (mg/kg-day)
Chromium	Black duck	chronic NOAEL	1.00	Opresko et al. (1994)	1	1.00	0.806	0.806
Cobalt	Chicken (chicks)	chronic LOAEL	20.8	NRC (1984)	0.1	2.08	0.370	0.769
Copper	Chicken (chicks)	chronic NOAEL	33.21	Opresko et al. (1994)	1	33.21	0.370	12.3
Iron	Chicken (chicks)	chronic NOAEL	70	NRC (1984)	1	70	0.370	25.9
Lead	American kestrel	chronic NOAEL	3.85	Opresko et al. (1994)	1	3.85	0.379	1.46
Manganese	Rat	chronic NOAEL	88	Opresko et al. (1994)	0.1	8.8	0.527	4.64
Mercury	Mallard	chronic LOAEL	0.064	Opresko et al. (1994)	0.1	0.0064	0.784	0.0050
Nickel	Mallard (duckling)	chronic NOAEL	77.4	Opresko et al. (1994)	1	77.4	0.689	53.3
Selenium	Mallard	chronic NOAEL	0.4	Opresko et al. (1994)	1	0.4	0.784	0.314
Silver	Rat	chronic LOAEL	89	Olcott (1950)	0.01	0.89	0.527	0.469
Vanadium	Mallard	chronic NOAEL	11.4	Opresko et al. (1994)	1	11.4	0.784	8.94
Zinc	Mallard	subchronic LOAEL	300	Opresko et al. (1994)	0.01	3.0	0.784	2.35

1. Uncertainty factors were used as described in section 7.3.1.2.

TABLE 7-34. IRON HORSE PARK BENTHIC RECONNAISSANCE SUMMARY OF HABITAT PARAMETERS (from Plafkin et al., 1989)

Habitat Parameter	Excellent	Good	Fair	Poor
1. Bottom Scouring and Deposition	<5% of the bottom affected by scouring and deposition.	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	30-50% affected. Deposits and scour at obstructions, constrictions and bends. Some filling of pools.	>50% of bottom changing all year. Pools almost absent due to deposition. Only large rocks in riffle exposed.
2. Pool/riffle, run/bend ratio (distance between riffles ÷ stream width)	Variety of habitat. Deep riffles and pools.	Adequate depth in pools and riffles. Bends provide habitat.	Occasional riffles or bends. Bottom contours provide some habitat.	A straight stream. All flat water or shallow riffle. Poor habitat.
3. Bank Stability	Stable. No evidence of erosion or bank failure. Side slopes generally <30%. Little potential for future problems.	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods.	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% on some banks. High erosion potential with extended high flow.	Unstable. Many eroded areas. Side slopes >60% common. Raw areas frequent along straight sections and bends.
4. Bank Vegetative Stability	>80% of the streambank surfaces covered by vegetation or boulders and cobble.	50-79% of the streambank surfaces covered by vegetation, gravel or larger material.	25-49% of the streambank surfaces covered by vegetation, gravel or larger material.	<25% of the streambank surfaces covered by vegetation, gravel or larger material.
5. Streamside Cover	Dominant vegetation is shrub.	Dominant vegetation is tree form.	Dominant vegetation is grass or forbes.	>50% of bank has no vegetation.

TABLE 7-35. COMPARISON OF BIOTIC INDICES AMONG SURFACE WATER/SEDIMENT GROUPS AT THE IRON HORSE PARK SITE

Area	Site	Habitat	Number of Taxa	Number of individuals	EPT Present	% Organisms EPT	Chironomids Present	EPT/Chironomid Ratio	Vertebrates Present	Mollusca	Amphipoda
Reference	MC-01	Lotic	8	64	Yes	2	Yes	0.50	0	53	3
	RS-01	Lotic	9	117	Yes	3	No	--	0	54	42
	RS-02	Lotic	10	> 139	No	0	Yes	0.00	0	64	> 50
	RP-04	Lentic	7	25	No	0	No	--	0	5	0
	RW-01	Lentic	5	22	No	0	No	--	13	18	0
West Middlesex Canal Group	MC-02	Lotic	8	34	No	0	Yes	0.00	0	22	0
	MC-03	Lotic	11	> 99	No	0	Yes	0.00	0	12	> 50
	MC-04	Lotic	7	38	No	0	Yes	0.00	0	6	20
Wetland 2 Group	UB-01	Lotic	9	93	Yes	< 1	Yes	0.17	0	28	> 50
	UB-03	Lotic	7	165	No	0	No	--	2	> 98	50
	UB-04	Lotic	9	29	Yes	17	Yes	5.00	0	13	5
	UB-02	Lentic	9	84	No	0	Yes	0.00	14	1	0
Richardson Pond Group	RP-01	Lotic	7	22	Yes	5	No	--	0	13	2
	RP-02	Lentic	3	4	No	0	No	--	0	0	2
	RP-03	Lentic	8	22	No	0	Yes	0.00	0	7	4
East Middlesex Canal Group	MC-05	Lotic	9	38	No	0	Yes	0.00	0	16	3
	MC-09	Lotic	5	31	Yes	10	No	--	0	0	19
	MC-10	Lotic	9	64	No	0	Yes	0.00	0	3	8

TABLE 7-35 (Continued). COMPARISON OF BIOTIC INDICES AMONG SURFACE WATER/SEDIMENT GROUPS AT THE IRON HORSE PARK SITE

Area	Site	Habitat	Number of Taxa	Number of individuals	EPT Present	% Organisms EPT	Chironomids Present	EPT/Chironomid Ratio	Vertebrates Present	Mollusca	Amphipoda
Content Brook Wetland Group	CB-01	Lotic	4	21	No	0	Yes	0.00	0	5	0
	MC-06	Lotic	6	> 59	No	0	No	--	0	3	> 50
	MC-07	Lotic	11	55	Yes	4	No	--	0	6	36
	MC-08	Lotic	10	84	No	0	Yes	0.00	0	39	25
	CB-02	Lentic	4	19	No	0	Yes	0.00	0	0	0
	CB-03	Lentic	9	75	No	0	Yes	0.00	0	8	29

-- No ratio is calculated, because no chironomids were present.

TABLE 7-36. IRON HORSE PARK BENTHIC RECONNAISSANCE SUMMARY OF PHYSICAL PARAMETERS

STATION					HABITAT CHARACTERISTIC[1]				
	Associated Surface Water/ Sediment Location[2]	Water Depth (cm)	Flow	Sediment Description	Bottom Scouring and Deposition	Pool/Riffle Run/Bend Ratio[3]	Bank Stability	Bank Vegetative Stability	Streamside Cover
MC-01	None	13	Minimal	soft muck; black; highly organic/detritus	Fair	Fair	Good	Excellent	Excellent
MC-02	308	18	Minimal	detritus/litter	Good	Good	Excellent	Excellent	Excellent
MC-03	305	23	Low	detritus/organic muck	Good	Good	Good	Good	Fair
MC-04	029	25	Minimal	detritus/organic muck	Fair	Fair	Good	Good	Good
MC-05	017	18	Moderate	detritus/organic muck	Poor	Fair	Fair	Fair	Good
MC-06	102	20	None	detritus/litter	Fair	Poor	Good	Good	Good
MC-07	020	10	Moderate	detritus/litter/sandy	Fair	Good	Good	Good	Excellent
MC-08	None	13	Moderate	detritus/organic muck	Good	Good	Excellent	Excellent	Excellent
MC-09	105	10	Moderate	detritus/litter/gravel to coarse sand	Fair	Poor	Fair	Good	Excellent
MC-10	116	13	Low	thick/black/highly organic; detritus	Fair	Fair	Good	Good	Excellent
RP-01	111	13	None	detritus/silt	Good	Poor	Good	Excellent	Excellent
RP-02	309	10	None	detritus/litter	N/A[4]	N/A	Fair	Fair	N/A
RP-03	None	30	None	detritus/organic muck	N/A	N/A	Excellent	Excellent	N/A
RP-04	320	15	None	detritus/organic muck	N/A	N/A	Excellent	Excellent	N/A
RS-01	321	10	Minimal	firm, gravelly	Good	Fair	Good	Good	Excellent

TABLE 7-36 (Cont'd). IRON HORSE PARK BENTHIC RECONNAISSANCE SUMMARY OF PHYSICAL PARAMETERS

STATION					HABITAT CHARACTERISTIC[1]				
	Associated Surface Water/ Sediment Location[2]	Water Depth (cm)	Flow	Sediment Description	Bottom Scouring and Deposition	Pool/Riffle Run/Bend Ratio[3]	Bank Stability	Bank Vegetative Stability	Streamside Cover
RS-02	None	13	Minimal	organic muck/black/ soft; detritus	Good	Poor	Good	Excellent	Fair
CB-01	None	18	None	detritus	Good	Fair	Good	Good	Fair
CB-02[5]	117	15	None	detritus/litter	N/A	N/A	Fair	Fair	N/A
CB-03[5]	None	25	None	detritus/litter	N/A	N/A	Good	Good	N/A
UB-01	317	25	Moderate	detritus/litter	Good	Good	Excellent	Excellent	Excellent
UB-02[5]	None	18	None	detritus	N/A	N/A	Fair	Fair	N/A
UB-03[5]	010	15	Minimal	detritus/organic muck/litter	Fair	Good	Good	Good	Good
UB-04[5]	301	15	Moderate	sandy (some litter)	Poor	Fair	Fair	Fair	Good
RW-01	319	15	None	detritus	N/A	N/A	Excellent	Excellent	N/A

1 See text and Plafkin et al. (1989) for definition of habitat variable ratings.
2 Surface water/sediment location sampled by M&E in June and September 1993.
3 Distance between riffles ÷ stream width (see Plafkin et al., 1989).
4 Not Applicable - lentic habitat.
5 Sediment malodorous (petroleum odor) when disturbed.

TABLE 7-37. SURFACE WATER PARAMETERS, IRON HORSE PARK, FALL 1993

STATION	Associated SW/SD Location	Date	pH	Specific Conductance (μmhos/cm)	Dissolved Oxygen (mg/L)	Temperature (°C)
MC-01	None	10/06/93	6.0	218	3.6	6.2
MC-02	308	09/14/93	6.6	180	2.0	18.9
MC-03	305	09/16/93	6.6	200	4.9	17.8
MC-04	029	09/17/93	7.6	280	8.0	14.0
MC-05	017	09/15/93	6.8	415	3.2	18.9
MC-06	102	09/15/93	6.8	490	4.7	18.3
MC-07	020	09/15/93	7.1	420	6.4	18.9
MC-09	105	09/22/93	6.4	520	8.2	13.8
MC-10	116	09/17/93	7.4	500	6.0	15.0
RP-01	111	09/21/93	5.3	400	3.0	12.8
RP-02	309	09/21/93	5.1	390	1.0	----
RP-04	320	09/20/93	6.2	360	3.0	13.3
RS-01	321	09/17/93	7.2	280	6.5	15.0
CB-02	117	09/21/93	7.3	760	4.0	14.0
UB-01	317	09/14/93	6.5	120	6.5	24.4
UB-03	010	09/14/93	5.9	660	4.2	25.0
UB-04	310	09/16/93	7.6	760	6.5	17.0
RW-01	319	09/22/93	8.7	200	6.0	14.0

TABLE 7-38. IRON HORSE PARK BENTHIC RECONNAISSANCE - OCTOBER 6 AND 7, 1993. NUMBER OF ORGANISMS BY TAXA.

TAXA				STATION[1]																									
Phylum	Class	Order	Family	MC 01	MC 02	MC 03	MC 04	MC 05	MC 06	MC 07	MC 08	MC 09	MC 10	RP 01	RP 02	RP 03	RP 04	RP 04G	RS 01	RS 02	CB 01	CB 02	CB 03	UB 01	UB 02	UB 03	UB 04	RW 01	RW 01G
Annelida									1				1											1			2		
	Hirudinea				2	3		3								1	2		2	2					3		2		
	Oligochaeta				1						1			1									3						
Mollusca																													
	Gastropoda			48	6	7	6	3	3	5	35			6		7	5		47	14	3		5	28	1	48	1	18	
			Planorbidae															1											
	Bivalvia[2]			5	16	5		13		1	4		3	7					7	50	2					>50	12		
Arthro-poda	Arachnida																												
		Araneae[3]				1											1												
	Crustacea																												
		Amphipoda[2]					20		>50					2	2	4													
			Gammeridae[2]	3		200		3		36	25	19	8						42	82			4	200		50	5		
		Isopoda				3	7	4	2	2	7	7								5			25	1	11			1	
		Decapoda											2																
	Insecta																												
		Odonata																											
			Anisoptera[4]	2					2	2						1	3		1			10	17		2	1		1	
			Libellulidae															1											
			Zygoptera[4]		1	8			1	2							1			1		1	2	1		7			
		Hemiptera		1		15	2	4		1	6		3	2	1	2	12		10	1	3	3	3		1	8			
			Corixidae																						6				
			Notonectidae																						3				
		Coleoptera																								1			
			Coccinellidae[5]																									1	
		Lepidoptera									1	1																1	
		Neuroptera																											
			Sialidae			2					2		1											3					
			Corydalidae			1						1			1	1													
		Diptera		2	1		1	1		1	2		26			3			1	3				2	55		1		
			Tipulidae							2																			
			Empididae																3										
			Simulidae					1																					
			Tabanidae							1																			
			Culicidae																										
			Chironomidae	2	6	4	1	6			1		1			3				12	13	5	15	6	2		1		
			Ptychopteridae		1		1						19	3						1			1						
			Stratiomyidae														1												
		Trichoptera		1						2									4					1			1		
			Hydropsychidae									3		1													4		
			EPT	Yes	No	No	No	No	No	Yes	No	Yes	No	Yes	No	No	No	No	Yes	No	No	No	No	Yes	No	No	Yes	No	No
			% EPT	2	0	0	0	0	0	4	0	10	0	5	0	0	0	0	3	0	0	0	0	<1	0	0	17	0	0
			Chironomids	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No
			EPT/Chironomid	0.50	0.00	0.00	0.00	0.00	--	***	0.00	***	0.00	***	--	0.00	--	--	***	0.00	0.00	0.00	0.00	0.17	0.00	--	5.00	--	--
			Bluegill																							1		4	
			Tadpoles																						14	1		9	

1 See Figure 7–4 for station locations. Station numbers followed by a "G" indicate grab samples.
2 50 was the upper bound count
3 Non–aquatic specimen collected at Stations MC–03 and RP–04/m
4 Suborder
5 Non–aquatic specimen collected at Station RW–01
6 –– Neither EPT nor Chironomids present; *** Chironomids not present.

TABLE 7-39. COMPARISON OF AVERAGE AND MAXIMUM SURFACE SOIL CONCENTRATIONS TO EARTHWORM TRV's FOR COPC IN SURFACE SOIL

Analyte	Average Concentration	Maximum Concentration	Earthworm TRV's (1)	Ratio of Average Concentration to Earthworm TRV	Ratio of Maximum Concentration to Earthworm TRV
B&M Railroad Landfill					
Volatile Organics (µg/kg)					
Methylene Chloride	93.6	280	NA	---	---
Semivolatile Organics (µg/kg)					
Acenaphthene	1,660	340	NA	---	---
Acenaphthylene	1,670	3,200	NA	---	---
Benzo(a)anthracene	3,540	16,000	1,000 (2)	3.54	16.0
Benzo(a)pyrene	3,590	18,000	5 (3)	718	3,600
Benzo(b)fluoranthene	8,210	33,000	19,000 (4)	0.432	1.74
Benzo(g,h,i)perylene	1,940	10,000	1,000 (5)	1.94	10.0
Butylbenzylphthalate	2,940	10,000	NA	---	---
Carbazole	1,530	3,400	NA	---	---
Chrysene	4,020	20,000	5,000 (2)	0.804	4.0
Dibenzo(a,h)anthracene	1,610	4,200	1,000 (2)	1.61	4.20
Dibenzofuran	1,680	290	NA	---	---
Fluoranthene	6,050	28,000	10,000 (6)	0.605	2.80
Indeno(1,2,3-cd)pyrene	2,030	10,000	1,000 (5)	2.03	10.0
2-Methylnaphthalene	1,670	260	NA	---	---
Phenanthrene	2,510	17,000	5,000 (6)	0.502	3.40
Pyrene	6,250	24,000	10,000 (6)	0.625	2.40
Pesticides and PCBs (µg/kg)					
Aldrin	1.57	3.9	NA	---	---
4,4'-DDT	62.1	230	100 (7)	0.621	2.30
Endrin	55.6	140	NA	---	---
Endrin Aldehyde	29.1	110	NA	---	---
Endrin Ketone	55.9	170	NA	---	---
Methoxychlor	66.0	170	NA	---	---
Inorganics (mg/kg)					
Antimony	16.9	155	4.5 (7)	3.76	34.4
Barium	258	922	400 (8)	0.645	2.31
Cadmium	7.59	34.8	20 (9)	0.380	1.74
Chromium	73.9	304	0.4 (9)	185	760

TABLE 7-39 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SURFACE SOIL CONCENTRATIONS TO EARTHWORM TRV's FOR COPC IN SURFACE SOIL

Analyte	Average Concentration	Maximum Concentration	Earthworm TRV's (1)	Ratio of Average Concentration to Earthworm TRV	Ratio of Maximum Concentration to Earthworm TRV
Copper	361	1,030	50 (9)	7.22	20.6
Cyanide	3.76	39.0	NA	---	--
Iron	35,300	76,800	NA	---	---
Lead	559	1,130	500 (9)	1.12	2.26
Mercury	1.07	3.40	0.1 (9)	10.7	34.0
Zinc	1,240	4,400	200 (9)	6.20	22.0
<u>**RSI Landfill**</u>					
Volatile Organics (µg/kg)					
Methylene Chloride	116	64	NA	---	---
Pesticides and PCBs (µg/kg)					
Endrin	1.01	1.4	NA	---	---
Endrin Ketone	1.21	0.87	NA	---	---
Methoxychlor	5.68	4.0	NA	---	---
Inorganics (mg/kg)					
Chromium	13.9	24	0.4 (9)	34.8	59.3
Iron	9,710	13,600	NA	---	---
<u>**B&M Locomotive Shop Disposal Area**</u>					
Volatile Organics (µg/kg)					
Methylene Chloride	9.90	21	NA	---	---
Semivolatile Organics (µg/kg)					
Acenaphthene	304	790	NA	---	---
Acenaphthylene	146	20	NA	---	---
Benzo(a)anthracene	666	2,300	1,000 (2)	0.666	2.30
Benzo(a)pyrene	503	1,700	5 (3)	101	340
Chrysene	707	2,400	5,000 (2)	0.141	0.480
2-Methylnaphthalene	224	370	NA	---	---
Phenanthrene	1,380	5,900	5,000 (6)	0.276	1.18
Pesticides and PCBs (µg/kg)					
Aldrin	1.43	2.8	NA	---	---
Endrin	1.82	3.5	NA	---	---

TABLE 7-39 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SURFACE SOIL CONCENTRATIONS TO EARTHWORM TRV's FOR COPC IN SURFACE SOIL

Analyte	Average Concentration	Maximum Concentration	Earthworm TRV's (1)	Ratio of Average Concentration to Earthworm TRV	Ratio of Maximum Concentration to Earthworm TRV
Endrin Ketone	2.57	5.6	NA	---	---
Methoxychlor	9.48	19	NA	---	---
Inorganics (mg/kg)					
Antimony	14.2	53.0	4.5 (7)	3.16	11.8
Chromium	31.1	87.4	0.4 (9)	77.8	219
Copper	734	3,135	50 (9)	14.7	62.7
Iron	34,800	101,350	NA	---	---
Lead	575	2,370	500 (9)	1.15	4.74
Mercury	0.103	0.190	0.1 (9)	1.03	1.90
Zinc	222	821	200 (9)	1.11	4.11

NOTES:

1. Note that earthworm TRVs consist of toxicological benchmarks developed for earthworms, as well as acceptable soil levels, soil clean-up levels and maximum allowable contaminant levels derived for the protection of the environment. See Section 7.1.2.3 for further details.
2. Indicative of moderate soil contamination as designated by the soil cleanup criteria of Quebec (as cited in Beyer 1990).
3. Acceptable on-site concentration proposed by Ontario Ministry of Environment (as cited in Beyer 1990).
4. Kappleman (1993).
5. Fitchko (1989).
6. Soil criteria for evaluating the severity of contamination under the Dutch Soil Cleanup (Interim) Act (as cited in Beyer 1990).
7. Maximum allowable soil concentration in the former Soviet Union (as cited in Beyer 1990).
8. Guidelines for the New Jersey Environmental Cleanup Responsibility Act (as cited in Beyer 1990).
9. Will and Suter (1994).

NA = Not applicable, TRVs were not available from scientific literature.

TABLE 7-40. COMPARISON OF AVERAGE AND MAXIMUM CONCENTRATIONS TO SCREENING SURFACE WATER TRV's FOR COPC IN SURFACE WATER

Analyte	Average Concentration	Maximum Concentration	Surface Water TRV	Ratio of Average Concentration to Screening Criteria	Ratio of Maximum Concentration to Screening Criteria
West Middlesex Canal Group					
Pesticides and PCBs (ug/l) - June 1993					
Aldrin	0.00115	0.00064	NA	---	---
Wetland 2 Group					
Semivolatile Organics (ug/l) - June 1993					
Pyrene	4.47	1.0	NA	---	---
Semivolatile Organics (ug/l) - September 1993					
Pyrene	4.71	1.0	NA	---	---
Pesticides and PCBs (ug/l) - June 1993					
Aldrin	0.00121	0.00069	NA	---	---
Inorganics (ug/l) - June 1993					
Barium	61.3	156	3.8 (1)	16.1	41.1
Chromium	3.16	11.5	11 (2,3)	0.287	1.0
Copper	7.75	29.8	8.1 (4)	0.957	3.68
Iron	10,200	53,300	1,000 (2)	10.2	53.3
Lead	16.3	59.1	1.8 (4)	9.06	32.8
Mercury	0.0653	0.180	0.012 (2)	5.44	15.0
Zinc	36.1	165	73.2 (4)	0.493	2.25
Inorganics (ug/l) - September 1993					
Barium	99.2	842	3.8 (1)	26.1	222
Chromium	5.51	36.9	11 (2,3)	0.501	3.35
Copper	49.9	636	8.6 (4)	5.80	74.0
Iron	8,880	90,500	1,000 (2)	8.88	90.5
Lead	54.2	630	2 (4)	27.1	315
Nickel	25.2	324	115 (4)	0.219	2.82
Silver	1.91	6.50	0.36 (1)	5.31	18.1
Vanadium	4.59	38.9	19.1 (1)	0.240	2.04
Zinc	383	5,100	77.2 (4)	4.96	66.1
East Middlesex Canal Group					
Pesticides and PCBs (ug/l) - June 1993					
Methoxychlor	0.0146	0.025	0.019 (5)	0.768	1.32

TABLE 7-40(Continued). COMPARISON OF AVERAGE AND MAXIMUM CONCENTRATIONS TO SURFACE WATER TRV's FOR COPC IN SURFACE WATER

Analyte	Average Concentration	Maximum Concentration	Surface Water TRV	Ratio of Average Concentration to Screening Criteria	Ratio of Maximum Concentration to Screening Criteria
Richardson Pond Group					
Semivolatile Organics (ug/l) - June 1993					
Pyrene	3.95	1.0	NA	---	---
Semivolatile Organics (ug/l) - September 1993					
Pyrene	4.57	2.0	NA	---	---
Pesticides and PCBs (ug/l) - September 1993					
4,4'-DDD	0.00564	0.025	0.01 (1)	0.564	2.45
Inorganics (ug/l) - June 1993					
Barium	103	414	3.8 (1)	27.1	109
Cobalt	2.09	6.6	3.06 (1)	0.683	2.16
Iron	26,300	137,000	1,000 (2)	26.3	137
Lead	21.6	138	2 (4)	10.8	69.0
Mercury	0.0638	0.160	0.012 (2)	5.32	13.3
Silver	3.22	14.2	0.36 (1)	8.94	39.4
Zinc	28.9	193	77.5 (4)	0.373	2.49
Inorganics (ug/l) - September 1993					
Aluminum	6,830	41,700	87 (2,6)	78.5	479
Barium	163	802	3.8 (1)	42.9	211
Chromium	14.6	92.3	11 (2,3)	1.33	8.39
Copper	47.0	299	9.5 (4)	4.95	31.5
Iron	31,400	116,150	1,000 (2)	31.4	116
Lead	92.9	517	2.3 (4)	40.4	225
Selenium	2.44	6.10	5 (2)	0.488	1.22
Silver	2.96	9.15	0.36 (1)	8.22	25.4
Vanadium	19.8	102	19.1 (1)	1.04	5.35
Zinc	412	2,780	85.5 (4)	4.82	32.5
Content Brook Wetland Group					
Volatile Organics (ug/l) - June 1993					
Xylenes (total)	23.3	120	86.2 (1)	0.270	1.39
Semivolatile Organics (ug/l) - June 1993					
Pyrene	4.43	1.0	NA	---	---
Pesticides and PCBs (ug/l) - June 1993					

TABLE 7-40(Continued). COMPARISON OF AVERAGE AND MAXIMUM CONCENTRATIONS TO SURFACE WATER TRV's FOR COPC IN SURFACE WATER

Analyte	Average Concentration	Maximum Concentration	Surface Water TRV	Ratio of Average Concentration to Screening Criteria	Ratio of Maximum Concentration to Screening Criteria
alpha-Chlordane	0.00200	0.0050	0.0043 (2,7)	0.465	1.16
Inorganics (ug/l) - June 1993					
Aluminum	12,100	65,000	87 (2,6)	139	747
Arsenic	2,320	13,000	190 (8)	12.2	68.4
Barium	2,270	10,300	3.8 (1)	597	2,711
Chromium	29.1	133	11 (2,3)	2.65	12.1
Cobalt	16.0	51.6	3.06 (1)	5.23	16.9
Copper	18.7	120	33.2 (4)	0.563	3.61
Iron	357,000	1,290,000	1,000 (2)	357	1,290
Lead	40.3	211	14.8 (4)	2.72	14.3
Manganese	3,500	13,500	80.3 (1)	43.6	168
Nickel	32.2	118	438 (4)	<0.1	0.269
Selenium	8.20	27.6	5 (2)	1.64	5.52
Silver	15.4	54.0	0.36 (1)	42.8	150
Vanadium	49.8	211	19.1 (1)	2.61	11.0
Zinc	123	530	295 (4)	0.417	1.80
Inorganics (ug/l) - September 1993					
Aluminum	2,410	12,500	87 (2,6)	27.7	144
Arsenic	181	676	190 (8)	0.953	3.56
Barium	234	595	3.8 (1)	61.6	157
Chromium	6.56	23.4	11 (2,3)	0.596	2.13
Copper	6.61	31.8	21.7 (4)	0.305	1.47
Iron	27,100	77,200	1,000 (2)	27.1	77.2
Lead	89.6	551	7.9 (4)	11.3	69.7
Vanadium	8.07	29.3	19.1 (1)	0.423	1.53

NOTES:

1. Suter and Mabrey (1994).
2. Chronic ambient water quality criterion (USEPA 1996c).
3. Chronic AWQC for chromium +6 conservatively used.
4. Hardness-dependent value (USEPA 1992i)
5. Ecotox threshold value (USEPA 1996b).
6. Also USEPA (1988b).
7. Chronic AWQC for chlordane.
8. Chronic AWQC for arsenic +3 conservatively used.

NA = Not applicable, TRVs were not available from scientific literature.

TABLE 7-41. COMPARISON OF AVERAGE AND MAXIMUM SEDIMENT CONCENTRATIONS TO SEDIMENT TRV's FOR COPC IN SEDIMENT

Analyte	Average Concentration	Maximum Concentration	Sediment TRV	Ratio of Average Concentration to Sediment TRV	Ratio of Maximum Concentration to Sediment TRV
West Middlesex Canal Group					
Volatile Organics (µg/kg)					
2-Butanone	10.7	22	NA	---	---
Semivolatile Organics (µg/kg)					
Benzo(a)anthracene	4,080	2,600	320 (1)	12.8	8.13
Benzo(b)fluoranthene	3,870	3,600	240 (1,2)	16.1	15.0
Benzo(k)fluoranthene	4,170	3,000	240 (1)	17.4	12.5
Butylbenzylphthalate	4,580	350	240 (3)	19.1	1.46
Chrysene	3,610	3,600	340 (1)	10.6	10.6
Fluoranthene	3,740	5,400	750 (1)	4.99	7.20
2-Methylnaphthalene	4,020	1,500	70 (4)	57.4	21.4
Phenanthrene	3,740	2,000	560 (1)	6.68	3.57
Pyrene	4,230	620	490 (1)	8.63	1.27
Pesticides and PCBs (µg/kg)					
alpha-Chlordane	3.61	18	7 (1,5)	0.516	2.57
gamma-Chlordane	2.91	18	7 (1,5)	0.416	2.57
4,4'-DDD	7.15	34	8 (1)	0.894	4.25
4,4'-DDE	4.14	18	5 (1)	0.828	3.60
Dieldrin	2.61	10	2 (1)	1.31	5.0
Endosulfan I	1.31	2.0	NA	---	---
Endosulfan II	2.81	2.0	NA	---	---
Endrin	2.84	5.3	3 (1)	0.947	1.77
Methoxychlor	12.9	7.6	NA	---	---
Aroclor-1248	258	2,000	30 (1)	8.60	66.7
Inorganics (mg/kg)					
Aluminum	8,150	29,400	NA	---	---
Arsenic	16.4	101	6 (1)	2.73	16.8
Barium	46.0	111	NA	---	---
Beryllium	0.567	3.80	NA	---	---
Cadmium	0.771	5.40	0.6 (1)	1.29	9.0
Chromium	25.4	100	26 (1)	0.977	3.85
Cobalt	8.39	48.6	NA	---	---

TABLE 7-41 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SEDIMENT CONCENTRATIONS TO *SEDIMENT TRV's FOR COPC IN SEDIMENT*

Analyte	Average Concentration	Maximum Concentration	Sediment TRV	Ratio of Average Concentration to Sediment TRV	Ratio of Maximum Concentration to Sediment TRV
Cobalt	8.39	48.6	NA	---	---
Copper	36.6	215	16 (1)	2.29	13.4
Iron	10,500	33,550	20,000 (1)	0.525	1.68
Lead	86.9	554	31 (1)	2.80	17.9
Manganese	437	2,745	460 (1)	0.950	5.97
Mercury	0.103	0.480	0.2 (1)	0.515	2.40
Nickel	18.0	132	16 (1)	1.13	8.25
Selenium	1.55	7.20	NA	---	---
Vanadium	24.1	110	NA	---	---
Zinc	105	504	120 (1)	0.875	4.20
<u>**Wetland 2 Group**</u>					
Volatile Organics (μg/kg)					
2-Butanone	31.9	300	NA	---	---
Semivolatile Organics (μg/kg)					
Acenaphthene	924	2,600	16 (4)	57.8	163
Acenaphthylene	952	2,200	1,323 (3)	0.720	1.66
Anthracene	986	5,200	220 (1)	4.48	23.6
Benzo(a)anthracene	2,440	40,000	320 (1)	7.63	125
Benzo(a)pyrene	1,530	18,000	370 (1)	4.14	48.6
Benzo(b)fluoranthene	3,100	60,000	240 (1,2)	12.9	250
Benzo(g,h,i)perylene	1,470	740	170 (1)	8.65	4.35
Benzo(k)fluoranthene	1,520	2,500	240 (1)	6.33	10.4
Butylbenzylphthalate	1,470	1,800	240 (3)	6.13	7.50
Carbazole	929	2,300	NA	---	---
Chrysene	1,810	25,000	340 (1)	5.32	73.5
Dibenzo(a,h)anthracene	1,480	140	60 (1)	24.7	2.33
Fluoranthene	2,860	48,000	750 (1)	3.81	64.0
Fluorene	684	3,300	190 (1)	3.60	17.4
Indeno(1,2,3-cd)pyrene	1,560	18,000	200 (1)	7.80	90.0
2-Methylnaphthalene	901	1,500	70 (4)	12.9	21.4
4-Methylphenol	952	2,900	NA	---	---
Naphthalene	896	2,300	160 (4)	5.60	14.4

TABLE 7-41 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SEDIMENT CONCENTRATIONS TO SEDIMENT TRV's FOR COPC IN SEDIMENT

Analyte	Average Concentration	Maximum Concentration	Sediment TRV	Ratio of Average Concentration to Sediment TRV	Ratio of Maximum Concentration to Sediment TRV
N-Nitrosodiphenylamine	1,450	300	539 (3)	2.69	0.557
Phenanthrene	2,180	36,000	560 (1)	3.89	64.3
Pyrene	3,290	62,000	490 (1)	6.71	127
Pesticides and PCBs (μg/kg)					
delta-BHC	1.83	3.3	3 (1,6)	0.610	1.10
4,4'-DDD	9.23	83	8 (1)	1.15	10.4
4,4'-DDE	5.42	47	5 (1)	1.08	9.40
Dieldrin	4.37	17	2 (1)	2.19	8.50
Endosulfan II	2.76	8.0	NA	---	---
Endosulfan Sulfate	3.55	1.5	NA	---	---
Endrin	4.11	15	3 (1)	1.37	5.0
Endrin Aldehyde	11.2	190	3 (1,7)	3.73	63.3
Endrin Ketone	3.91	3.7	3 (1,7)	1.30	1.23
Methoxychlor	17.9	26	NA	---	---
Aroclor-1248	52.4	570	30 (1)	1.75	19.0
Aroclor-1254	49.8	320	60 (1)	0.830	5.33
Inorganics (mg/kg)					
Aluminum	6,950	30,200	NA	---	---
Antimony	12.0	158	2 (8)	6.0	79.0
Arsenic	14.9	40.8	6 (1)	2.48	6.80
Barium	61.7	197	NA	---	---
Beryllium	0.620	3.70	NA	---	---
Cadmium	0.460	3.40	0.6 (1)	0.767	5.67
Chromium	20.6	106	26 (1)	0.792	4.08
Cobalt	7.89	24.7	NA	---	---
Copper	259	3,600	16 (1)	16.2	225
Iron	13,600	50,200	20,000 (1)	0.680	2.51
Lead	302	2,970	31 (1)	9.74	95.8
Manganese	322	1,230	460 (1)	0.700	2.67
Mercury	0.159	0.950	0.2 (1)	0.795	4.75
Nickel	11.6	45.3	16 (1)	0.725	2.83
Selenium	2.05	10.2	NA	---	---

TABLE 7-41 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SEDIMENT CONCENTRATIONS TO SEDIMENT TRV's FOR COPC IN SEDIMENT

Analyte	Average Concentration	Maximum Concentration	Sediment TRV	Ratio of Average Concentration to Sediment TRV	Ratio of Maximum Concentration to Sediment TRV
Silver	0.901	2.90	1 (4)	0.901	2.90
Vanadium	15.9	52.5	NA	---	---
Zinc	167	998	120 (1)	1.39	8.32
East Middlesex Canal Group					
Volatile Organics (µg/kg)					
Acetone	30.7	120	316 (9)	<0.1	0.380
2-Butanone	13.2	35	NA	---	---
Pesticides and PCBs (µg/kg)					
4,4'-DDD	4.78	21	8 (1)	0.598	2.63
4,4'-DDE	2.72	7.2	5 (1)	0.544	1.44
Endosulfan I	1.60	1.2	NA	---	---
Endosulfan Sulfate	3.13	0.44	NA	---	---
Methoxychlor	17.9	0.42	NA	---	---
Inorganics (mg/kg)					
Arsenic	4.93	10.1	6 (1)	0.822	1.68
Barium	44.9	100	NA	---	---
Cobalt	4.56	10.0	NA	---	---
Lead	50.3	310	31 (1)	1.62	10.0
Manganese	549	2,700	460 (1)	1.19	5.87
Mercury	0.126	0.650	0.2 (1)	0.630	3.25
Selenium	0.770	2.10	NA	---	---
Vanadium	8.07	15.9	NA	---	---
Richardson Pond Group					
Volatile Organics (µg/kg)					
Acetone	109	503	316 (9)	0.345	1.59
Benzene	21.0	54	256 (9)	<0.1	0.211
2-Butanone	52.9	210	NA	---	---
1,2-Dichloroethene(total)	24.4	70	113 (9)	0.216	0.619
Xylenes (total)	103	990	1,585 (9)	<0.1	0.625
Semivolatile Organics (µg/kg)					
Acenaphthene	4,830	6,550	16 (4)	302	409
Anthracene	4,760	6,350	220 (1)	21.6	28.9

TABLE 7-41 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SEDIMENT CONCENTRATIONS TO SEDIMENT TRV's FOR COPC IN SEDIMENT

Analyte	Average Concentration	Maximum Concentration	Sediment TRV	Ratio of Average *Concentration to* Sediment TRV	Ratio of Maximum *Concentration to* Sediment TRV
Benzo(a)anthracene	6,800	21,000	320 (1)	21.3	65.6
Benzo(a)pyrene	5,510	15,000	370 (1)	14.9	40.5
Benzo(b)fluoranthene	6,050	19,000	240 (1,2)	25.2	79.2
Benzo(g,h,i)perylene	5,140	8,950	170 (1)	30.2	52.6
Benzo(k)fluoranthene	5,700	12,500	240 (1)	23.8	52.1
Butylbenzylphthalate	4,900	910	240 (3)	20.4	3.79
Chrysene	6,200	20,000	340 (1)	18.2	58.8
Dibenzo(a,h)anthracene	4,300	2,950	60 (1)	71.7	49.2
Fluoranthene	8,120	32,500	750 (1)	10.8	43.3
Fluorene	4,740	6,600	190 (1)	24.9	34.7
Indeno(1,2,3-cd)pyrene	4,890	7,700	200 (1)	24.5	38.5
2-Methylnaphthalene	5,090	190	70 (4)	72.7	2.71
4-Methylphenol	4,780	720	NA	---	---
Naphthalene	5,040	650	160 (4)	31.5	4.06
Phenanthrene	8,060	31,500	560 (1)	14.4	56.3
Pyrene	11,100	48,000	490 (1)	22.7	98.0
Pesticides and PCBs (μg/kg)					
Aldrin	4.24	2.4	2 (1)	2.12	1.20
4,4'-DDD	8.55	37	8 (1)	1.07	4.63
4,4'-DDE	8.64	20	5 (1)	1.73	4.0
4,4'-DDT	6.80	9.6	8 (1,10)	0.850	1.20
Dieldrin	8.0	10	2 (1)	4.0	5.0
Endosulfan I	3.10	3.4	NA	---	---
Endosulfan II	7.09	0.50	NA	---	---
Endosulfan Sulfate	8.21	1.8	NA	---	---
Endrin	8.70	14	3 (1)	2.90	4.67
Methoxychlor	32.4	12	NA	---	---
Inorganics (mg/kg)					
Aluminum	7,120	26,300	NA	---	---
Arsenic	6.91	26.5	6 (1)	1.15	4.41
Barium	67.5	287	NA	---	---
Beryllium	0.807	3.20	NA	---	---

TABLE 7-41 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SEDIMENT CONCENTRATIONS TO SEDIMENT TRV's FOR COPC IN SEDIMENT

Analyte	Average Concentration	Maximum Concentration	Sediment TRV	Ratio of Average Concentration to Sediment TRV	Ratio of Maximum Concentration to Sediment TRV
Cadmium	0.454	1.30	0.6 (1)	0.757	2.17
Chromium	19.4	64.6	26 (1)	0.746	2.48
Cobalt	5.84	19.9	NA	---	---
Copper	46.0	194	16 (1)	2.88	12.1
Iron	9,850	49,500	20,000 (1)	0.493	2.48
Lead	75.0	400	31 (1)	2.42	12.9
Manganese	229	1,160	460 (1)	0.498	2.52
Mercury	0.396	1.30	0.2 (1)	1.98	6.50
Nickel	15.6	46.7	16 (1)	0.975	2.92
Selenium	1.15	1.80	NA	---	---
Silver	1.04	2.30	1 (4)	1.04	2.30
Vanadium	19.2	76.4	NA	---	---
Zinc	133	669	120 (1)	1.11	5.58
<u>Content Brook Wetland Group</u>					
Volatile Organics (µg/kg)					
Acetone	28.0	112	316 (9)	<0.1	0.353
2-Butanone	18.9	79	NA	---	---
Xylenes (total)	53.2	410	1,585 (9)	<0.1	0.259
Semivolatile Organics (µg/kg)					
Acenaphthene	302	160	16 (4)	18.9	10.0
Benzo(a)anthracene	332	1,300	320 (1)	1.04	4.06
Benzo(a)pyrene	317	1,100	370 (1)	0.857	2.97
Benzo(b)fluoranthene	350	1,400	240 (1,2)	1.46	5.83
Benzo(g,h,i)perylene	315	470	170 (1)	1.85	2.76
Benzo(k)fluoranthene	392	1,300	240 (1)	1.63	5.42
Carbazole	310	270	NA	---	---
Chrysene	358	1,500	340 (1)	1.05	4.41
Dibenzo(a,h)anthracene	305	310	60 (1)	5.08	5.17
Fluoranthene	461	3,300	750 (1)	0.615	4.40
Fluorene	311	770	190 (1)	1.64	4.05
Indeno(1,2,3-cd)pyrene	266	590	200 (1)	1.33	2.95
2-Methylnaphthalene	270	130	70 (4)	3.86	1.86

TABLE 7-41 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SEDIMENT CONCENTRATIONS TO SEDIMENT TRV's FOR COPC IN SEDIMENT

Analyte	Average Concentration	Maximum Concentration	Sediment TRV	Ratio of Average Concentration to Sediment TRV	Ratio of Maximum Concentration to Sediment TRV
Naphthalene	169	450	160 (4)	1.06	2.81
Phenanthrene	396	2,700	560 (1)	0.707	4.82
Pyrene	455	3,100	490 (1)	0.929	6.33
Pesticides and PCBs (μg/kg)					
4,4'-DDD	3.77	16	8 (1)	0.471	2.04
4,4'-DDE	2.89	6.4	5 (1)	0.578	1.28
Dieldrin	2.47	2.7	2 (1)	1.24	1.35
Endosulfan I	1.48	0.39	NA	---	---
Endosulfan II	3.35	9.4	NA	---	---
Endosulfan Sulfate	2.91	0.30	NA	---	---
Heptachlor Epoxide	1.06	0.33	5 (1)	0.212	<0.1
Methoxychlor	12.2	14	NA	---	---
Inorganics (mg/kg)					
Aluminum	7,550	32,300	NA	---	---
Arsenic	42.8	256	6 (1)	7.13	42.7
Barium	62.8	253	NA	---	---
Chromium	11.7	56.5	26 (1)	0.450	2.17
Cobalt	5.52	17.7	NA	---	---
Copper	12.7	49.3	16 (1)	0.794	3.08
Iron	18,300	76,300	20,000 (1)	0.915	3.82
Lead	30.3	101	31 (1)	0.977	3.24
Manganese	417	2,080	460 (1)	0.907	4.52
Nickel	7.10	39.2	16 (1)	0.444	2.45
Selenium	0.982	2.50	NA	---	---
Silver	1.15	6.70	1 (4)	1.15	6.70

NOTES:

1. Omee 1993.
2. Value for benzo(k)fluoranthene.
3. Barrick and Beller.
4. Long et al 1995.
5. LEL for chlordane.

TABLE 7-41 (Continued). COMPARISON OF AVERAGE AND MAXIMUM SEDIMENT CONCENTRATIONS TO SEDIMENT TRV's FOR COPC IN SEDIMENT

NOTES (Continued):

6. Value for lindane conservatively used.
7. Value for endrin conservatively used.
8. NOAA (1991).
9. Hull and Suter (1994).
10. Value for op+pp DDT.

NA = Not applicable, TRVs were not available from scientific literature.

TABLE 7-42. HQs ABOVE 10 FOR EARTHWORMS AND SHORT-TAILED SHREW (1)

Receptor Species	B&M Railroad Landfill	RSI Landfill	B&M Locomotive Shop Disposal Areas (A and B)
Earthworms	*Average Exposure Case:*	*Average Exposure Case:*	*Average Exposure Case:*
	Benzo(a)pyrene	Chromium	Benzo(a)pyrene
	Chromium		Chromium
	Mercury		Copper
	Maximum Exposure Case:		*Maximum Exposure Case:*
	Benzo(a)anthracene		Antimony
	Antimony		
	Copper		
	Zinc		
Shrews	*Average Exposure Case:*	*Average Exposure Case:*	*Average Exposure Case:*
	Dibenzo(a,h)anthracene	Iron	Antimony
	Antimony		Iron
	Cadmium		*Maximum Exposure Case:*
	Iron		Copper
	Maximum Exposure Case:		Lead
	Cadmium		

NOTES:

1. HQs above 10 are indicative of the potential for significant reductions in the receptor species populations.

TABLE 7-43. HQs ABOVE 10 FOR AQUATIC RECEPTORS AND GREAT BLUE HERON (1)

Receptor Species	West Middlesex Canal Group	Wetland 2 Group	E. Middlesex Canal Group	Richardson Pond Group	Content Brook Wetland Group
Aquatic Receptors (Surface Water)	(2)	*Avg. Exposure Case:* Barium Iron Lead *Max. Exposure Case:* Copper Mercury Silver Zinc	(2)	*Avg. Exposure Case:* Barium Iron Lead *Max. Exposure Case:* Aluminum Copper Mercury Silver Zinc	*Avg. Exposure Case:* Aluminum Arsenic Barium Iron Manganese Silver *Max. Exposure Case:* Chromium Cobalt Copper Lead Vanadium
Aquatic Receptors (Sediment)	*Avg. Exposure Case:* Benzo(a)anthracene(3) Benzo(b)fluoranthene(4) Benzo(k)fluoranthene(4) Butylbenzylphthalate(3) Chrysene(4) 2-Methylnaphthalene(4) *Max. Exposure Case:* Copper Lead Arsenic Aroclor-1248	*Avg. Exposure Case:* Acenaphthene Dibenzo(a,h)anthracene(3) Copper Benzo(b)fluoranthene 2-Methylnaphthalene *Max. Exposure Case:* Fluorene Benzo(a)anthracene Benzo(a)pyrene Chrysene Anthracene Fluoranthene Lead 4,4'-DDD Indeno(1,2,3-cd)pyrene Benzo(k)fluoranthene Naphthalene Phenanthrene Pyrene Copper Antimony Endrin Aldehyde	(2)	*Avg. Exposure Case:* Acenaphthene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Butylbenzylphthalate (3) Chrysene Dibenzo(a,h)anthracene (4) Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene 2-Methylnaphthalene (3) Naphthalene (3) Phenanthrene Pyrene *Max. Exposure Case:* Acenaphthene Anthracene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene Phenanthrene Pyrene	*Avg. Exposure Case:* Acenaphthene (3) *Max. Exposure Case:* Arsenic
Great Blue Heron	(2)	*Avg. Exposure Case:* Dibenzo(a,h)anthracene (3) Mercury *Max. Exposure Case:* Antimony Zinc	(2)	*Avg. Exposure Case:* Dibenzo(a,h)anthracene (3) Zinc *Max. Exposure Case:* Aluminum Mercury	*Avg. Exposure Case:* Dibenzo(a,h)anthracene *Max. Exposure Case:* Dibenzo(a,h)anthracene Aluminum Arsenic Barium Iron Manganese Zinc

1. HQs above 10 are indicative of the potential for significant reductions in the receptor species populations.
2. No HQs greater than 10 in this surface water/sediment group.
3. The HQ for this COPC was based on an average concentration that was greater than the maximum concentration due to high detection limits. In addition, the maximum HQ was not greater than 10.
4. Both the average and maximum HQs were greater than 10. However, the average HQ for this COPC was based on an average concentration that was greater than the maximum concentration due to high detection limits.

TABLE 7-44. HAZARD INDICES FOR EARTHWORMS AND SHORT-TAILED SHREWS

Receptor Species	Exposure Pathway	Hazard Indices (1) Inorganics Average	Inorganics Maximum	SVOCs Average	SVOCs Maximum	Pesticides Average	Pesticides Maximum
Earthworms							
B&M Railroad Landfill							
	Ingestion of and Dermal absorption from Soil	2.1E+02	8.8E+02	7.3E+02	3.7E+03	6.2E-01	2.3E+00
RSI Landfill							
	Ingestion of and Dermal absorption from Soil	(3)	(3)	--	--	(2)	(2)
B&M Locomotive Shop Disposal Areas (Areas A and B)							
	Ingestion of and Dermal absorption from Soil	9.9E+01	3.0E+02	1.0E+02	3.4E+02	(2)	(2)
Shrews							
B&M Railroad Landfill							
	Ingestion of soil	1.1E+03	2.4E+03	5.5E+01	1.4E+02	7.3E-02	2.2E-01
	Ingestion of surface water	1.0E+00	1.0E+01	1.1E-04	2.4E-02	1.1E-06	6.1E-04
	Ingestion of earthworms	1.4E+03	3.1E+03	1.1E+01	2.8E+01	1.5E-01	4.4E-01
RSI Landfill							
	Ingestion of soil	2.9E+02	4.1E+02	--	--	1.1E-03	1.2E-03
	Ingestion of surface water	1.0E+00	1.0E+01	1.1E-04	2.4E-02	1.1E-06	6.1E-04
	Ingestion of earthworms	3.7E+02	5.2E+02	--	--	2.1E-03	2.2E-03
B&M Locomotive Shop Disposal Areas (Areas A and B)							
	Ingestion of soil	1.1E+03	3.1E+03	4.0E-02	1.4E-01	2.6E-03	5.3E-03
	Ingestion of surface water	1.0E+00	1.0E+01	1.1E-04	2.4E-02	1.1E-06	6.1E-04
	Ingestion of earthworms	1.3E+03	3.9E+03	5.7E-03	1.9E-02	1.0E-02	2.1E-02

NOTES:

1. Average and maximum hazard indices represent the sum of average and maximum hazard quotients, respectively.
2. TRVs were not available to calculate HQs.
3. HQs for earthworms were derived for only one COPC from this chemical class. Therefore, no HIs are presented.

-- = No chemicals from this class were selected as COPCs.

TABLE 7-45. HAZARD INDICES FOR AQUATIC RECEPTORS (SURFACE WATER) AND GREAT BLUE HERON

Receptor Species or Taxa Group	Exposure Pathway	Hazard Indices (1) High Flow Inorganics AVG	High Flow Inorganics MAX	Low Flow Inorganics AVG	Low Flow Inorganics MAX	High Flow SVOCs AVG (2)	High Flow SVOCs MAX	Low Flow SVOCs AVG (2)	Low Flow SVOCs MAX	High Flow Pesticides AVG	High Flow Pesticides MAX	Low Flow Pesticides AVG	Low Flow Pesticides MAX	High Flow PCBs AVG	High Flow PCBs MAX	Low Flow PCBs AVG	Low Flow PCBs MAX
Aquatic Receptors(3)																	
West Middlesex Canal Group		--	--	--	--	--	--	--	--	(4)	(4)	--	--	--	--	--	--
Wetland 2 Group		4.3E+01	1.5E+02	7.9E+01	7.9E+02	(4)	(4)	(4)	(4)	(4)	(4)	--	--	--	--	--	--
East Middlesex Canal Group		--	--	--	--	--	--	--	--	(5)	(5)	--	--	--	--	--	--
Richardson Pond		8.0E+01	3.7E+02	2.1E+02	1.1E+03	(4)	(4)	(4)	(4)	--	--	(5)	(5)	--	--	--	--
Content Brook Wetland Group		1.2E+03	5.2E+03	1.3E+02	4.6E+02	(4)	(4)	--	--	(5)	(5)	(5)	(5)	--	--	--	--
Great Blue Heron																	
West Middlesex Canal Group																	
	Ingestion of Sediment	1.6E+00	6.8E-03	1.6E+00	6.8E-03	1.8E-01	1.0E-01	1.8E-01	1.0E-01	5.2E-04	8.9E-04	2.1E-04	7.1E-04	2.6E-02	2.0E-01	2.6E-02	2.0E-01
	Ingestion of Surface Water	--	--	--	--	--	--	--	--	1.6E-04	6.1E-04	--	--	--	--	--	--
	Ingestion of Fish	--	--	--	--	(6)	(6)	(6)	(6)	3.7E-04	1.5E-03	3.6E-04	1.5E-03	1.1E-02	8.8E-02	1.1E-02	8.8E-02
Wetland 2 Group																	
	Ingestion of Sediment	9.5E+00	1.1E+02	9.5E+00	1.1E+02	8.3E+01	1.1E+01	8.3E+01	1.1E+01	2.1E-03	2.5E-02	1.7E-03	2.5E-02	2.9E-02	1.5E-01	2.9E-02	2.1E-01
	Ingestion of Surface Water	1.0E-02	5.0E-02	1.3E-02	1.4E-01	5.8E-04	1.3E-04	6.1E-04	1.3E-04	3.6E-04	2.5E-03	--	--	--	--	--	--
	Ingestion of Fish	9.8E+01	2.7E+02	1.5E+01	1.9E+02	(6)	(6)	(6)	(6)	8.4E-04	9.2E-03	8.3E-04	9.2E-03	5.6E-03	2.1E-02	5.6E-03	4.6E-02
East Middlesex Canal Group																	
	Ingestion of Sediment	3.6E-01	1.8E+00	3.6E-01	1.8E+00	--	--	--	--	1.0E-04	3.2E-04	7.7E-05	2.9E-04	--	--	--	--
	Ingestion of Surface Water	--	--	--	--	--	--	--	--	7.4E-05	7.4E-05	--	--	--	--	--	--
	Ingestion of Fish	--	--	--	--	--	--	--	--	1.7E-03	3.2E-03	2.3E-04	7.7E-04	--	--	--	--
Richardson Pond																	
	Ingestion of Sediment	1.6E+00	7.0E+00	1.6E+00	7.0E+00	2.4E+02	1.7E+02	2.4E+02	1.7E+02	6.4E-02	9.1E-02	7.0E-02	1.2E-01	--	--	--	--
	Ingestion of Surface Water	2.6E-02	1.4E-03	3.7E-02	1.6E-01	5.1E-04	1.3E-04	5.9E-04	2.6E-04	--	--	4.5E-03	6.1E-03	--	--	--	--
	Ingestion of Fish	1.6E+00	7.2E-01	2.0E+01	1.3E+02	(6)	(6)	(6)	(6)	7.9E-04	1.9E-03	2.1E-02	9.2E-02	--	--	--	--
Content Brook Wetland Group																	
	Ingestion of Sediment	2.0E+00	9.2E+00	2.0E+00	8.6E+00	1.7E+01	1.8E+01	1.7E+01	1.8E+01	3.5E-03	1.2E-02	2.9E-03	8.1E-03	--	--	--	--
	Ingestion of Surface Water	4.2E-01	1.7E+00	3.3E-02	1.1E-01	5.7E-04	1.3E-04	0.0E+00	0.0E+00	1.1E-04	1.4E-04	1.1E-04	1.4E-04	--	--	--	--
	Ingestion of Fish	2.4E+01	2.1E+02	2.3E+00	1.0E+01	(6)	(6)	(6)	(6)	1.8E-03	5.0E-03	1.9E-03	5.0E-03	--	--	--	--

NOTES:

1. Average and maximum hazard indices represent the sum of average and maximum hazard quotients, respectively.
2. *The HIs for great blue heron sediment ingestion are affected by average concentrations that were greater than the maximum concentrations due to high detection limits.* In every case where this occurs, the maximum HI is also greater than 10.
3. HIs for aquatic receptors were calculated using multiple exposure pathways for surface water.
4. TRVs were not available to calculate HQs.
5. HQs were derived for only one COPC for this chemical class. Therefore no HIs are presented.
6. SVOCs were assumed to be metabolized and excremented by fish. Thus, ingestion of SVOCs in fish was not evaluated.

-- = No chemicals from this class were selected as COPC in this medium at this area.

TABLE 7-46. HAZARD INDICES FOR AQUATIC RECEPTORS (SEDIMENT)

	Hazard Indices(1)									
	Inorganics		VOCs		SVOCs		Pesticides		PCBs	
Receptor or Taxa Group	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
Aquatic Invertebrates										
West Middlesex Canal Group										
	1.4E+01	8.3E+01	(2)	(2)	1.5E+02 (4)	8.3E+01	4.9E+00	2.0E+01	(3)	(3)
Wetland 2 Group										
	4.1E+01	4.4E+02	(2)	(2)	1.9E+02 (5)	1.1E+03	1.1E+01 (6)	9.9E+01	2.6E+00	2.4E+01
East Middlesex Canal Group										
	3.4E+00	1.9E+01	(3)	(3)	--	--	1.1E+00	4.1E+00	--	--
Richardson Pond										
	1.4E+01	5.6E+01	5.6E-01	3.1E+00	7.5E+02 (7)	1.1E+03	1.3E+01 (8)	2.1E+01	--	--
Content Brook Wetland Group										
	1.3E+01	6.9E+01	1.2E-02	6.0E-01	4.2E+01 (9)	6.8E+01	2.5E+00 (10)	4.7E+00	--	--

NOTES:

1. Average and maximum hazard indices represent the sum of average and maximum hazard quotients, respectively. HIs represent multiple exposure pathways from sediment.
2. TRVs were not available to calculate HQs.
3. HQs for aquatic invertebrates were derived for only one COPC from this chemical class. Therefore, no HIs are presented.
4. HI is biased high by the addition of 8 HQs in which the average concentration was greater than the maximum.
5. HI is biased high by the addition of 3 HQs in which the average concentration was greater than the maximum.
6. HI is biased high by the addition of 1 HQ in which the average concentration was greater than the maximum.
7. HI is biased high by the addition of 5 HQs in which the average concentration was greater than the maximum.
8. HI is biased high by the addition of 1 HQ in which the average concentration was greater than the maximum.
9. HI is biased high by the addition of 2 HQs in which the average concentration was greater than the maximum.
10. HI is biased high by the addition of 1 HQ in which the average concentration was greater than the maximum.

-- = No chemicals from this class were selected as COPCs.

TABLE 7-47. SUMMARY OF RELATIVE CONTRIBUTION OF CONTAMINANTS TO ECOLOGICAL RISK AND ASSOCIATED UNCERTAINTY AT B&M RAILROAD LANDFILL.

Endpoint	Contaminant (%HQ of HI)	Relative Contribution to Risk*	Relative Confidence in Risk Evaluation	Comment on Risk Evaluation
Earthworms	Benzo(a)pyrene (98)	High	Low	TRV is the acceptable on-site concentration proposed by Ontario Ministry of the Environment (Beyer, 1990). The confidence is low since the TRV is based on exposure model for human health.
	Chromium (88)	High	Low	The degree of association between measured chromium values and literature TRVs is low since TRV is a benchmark based on limited data (Will and Suter, 1995) showing toxicity to earthworms and because the relative contribution of forms of chromium [Cr(III) vs CR(VI)] to toxicity are not known.
	Mercury (5)	Low	Moderate	Although the TRV is species-specific, the confidence in the risk evaluation is moderate since the benchmark was derived from a limited amount of data (Will and Suter, 1995).
Shrews	Dibenzo(a,h)anthracene (100)	High	Low	The relative confidence in the risk evaluation is low since the TRV was derived from a mouse chronic LOAEL.
	Cadmium (1)	Low	Low	The relative confidence in the risk evaluation is low since the TRV was derived from a mouse chronic LOAEL.
	Antimony (0.7)	Low	Low	The relative confidence in the risk evaluation is low since the TRV was derived from a rat chronic LOAEL.
	Iron (98)	High	Low	The relative confidence in the risk evaluation is low since the TRV was derived from a mouse subchronic LD_{50}.

* Relative Contribution to risk is based on the proportion of the HI contributed by the HQ for that group of contaminants (inorganics, SVOCs or pesticides). Both HQs and HI used were based on average contaminant concentrations for each soil group. Relative contributions were assigned as follows:
Low = HQ is < 10% of HI
Moderate = HQ is 10% - 50% of HI
High = HQ is > 50% of HI

TABLE 7-48. SUMMARY OF RELATIVE CONTRIBUTION OF CONTAMINANTS TO ECOLOGICAL RISK AND ASSOCIATED UNCERTAINTY AT RSI LANDFILL.

Endpoint	Contaminant (%HQ of HI)	Relative Contribution to Risk*	Relative Confidence in Risk Evaluation	Comment on Risk Evaluation
Earthworms	Chromium (100)	High	Low	The degree of association between measured chromium values and literature TRVs is low since TRV is a benchmark based on limited data (Will and Suter, 1995) showing toxicity to earthworms and because the relative contribution of forms of chromium [Cr(III) vs CR(VI)] to toxicity are not known.
Shrews	Iron (100)	High	Low	The relative confidence in the risk evaluation is low since the TRV was derived from a mouse subchronic LD_{50}.

* Relative Contribution to risk is based on the proportion of the HI contributed by the HQ for that group of contaminants (inorganics, SVOCs or pesticides). Both HQs and HI used were based on average contaminant concentrations for each soil group. Relative contributions were assigned as follows:
Low = HQ is < 10% of HI
Moderate = HQ is 10% to 50% of HI
High = HQ is > 50% of HI

TABLE 7-49. SUMMARY OF RELATIVE CONTRIBUTION OF CONTAMINANTS TO ECOLOGICAL RISK AND ASSOCIATED UNCERTAINTY AT B&M LOCOMOTIVE SHOP DISPOSAL AREAS (A & B).

Endpoint	Contaminant (%HQ of HI)	Relative Contribution to Risk*	Relative Confidence in Risk Evaluation	Comment on Risk Evaluation
Earthworms	Benzo(a)pyrene (99)	High	Low	TRV is the acceptable on-site concentration proposed by Ontario Ministry of the Environment (Beyer, 1990). The confidence is low since the TRV is based on exposure model for human health.
	Chromium (79)	High	Low	The degree of association between measured chromium values and literature TRVs is low since TRV is a benchmark based on limited data (Will and Suter, 1995) showing toxicity to earthworms and because the relative contribution of forms of chromium [Cr(III) vs CR(VI)] to toxicity are not known.
	Copper (15)	Moderate	High	The TRV is organism-specific and based on sufficient data to rate a designation of high confidence as a benchmark (Will and Suter, 1995).
Shrews	Antimony (0.6)	Low	Low	The relative confidence in the risk evaluation is low since the TRV was derived from a mouse chronic LOAEL.
	Iron (99)	High	Low	The relative confidence in the risk evaluation is low since the TRV was derived from a mouse subchronic LD_{50}.

* Relative Contribution to risk is based on the proportion of the HI contributed by the HQ for that group of contaminants (inorganics, SVOCs or pesticides). Both HQs and HI used were based on average contaminant concentrations for each soil group. Relative contributions were assigned as follows:
Low = HQ is < 10% of HI
Moderate = HQ is 10% - 50% of HI
High = HQ is > 50% of HI

TABLE 7-50. SUMMARY OF RELATIVE CONTRIBUTION OF CONTAMINANTS TO ECOLOGICAL RISK AND ASSOCIATED UNCERTAINTY AT WEST MIDDLESEX CANAL GROUP.

Endpoint	Contaminant (%HQ of HI)	Relative Contribution to Risk*	Relative Confidence in Risk Evaluation	Comment on Risk Evaluation
Aquatic Receptors (surface water)	No COPCs with HQ >10			
Aquatic Receptors (sediment)	Benzo(a)anthracene (9)	Low	Low	High detection limit
	Benzo(b)fluoranthene (11)	Moderate	Low	High detection limit
	Benzo(k)fluoranthene (12)	Moderate	Low	High detection limit
	Butylbenzylphthalte (13)	Moderate	Low	High detection limit
	Chrysene (7)	Low	Low	High detection limit
	2-Methylnaphthalene (38)	Moderate	Low	High detection limit
Great Blue Heron	No COPCs with HQ>10			

* Relative Contribution to risk is based on the proportion of the HI contributed by the HQ for that group of contaminants (inorganics, SVOCs or pesticides). Both HQs and HI used were based on average contaminant concentrations for each soil group. Relative contributions were assigned as follows:
Low = HQ is < 10% of HI
Moderate = HQ is 10% - 50% of HI
High = HQ is > 50% of HI

TABLE 7-51. SUMMARY OF RELATIVE CONTRIBUTION OF CONTAMINANTS TO ECOLOGICAL RISK AND ASSOCIATED UNCERTAINTY AT WETLAND 2 GROUP.

Endpoint	Contaminant (%HQ of HI)	Relative Contribution to Risk*	Relative Confidence in Risk Evaluation	Comment on Risk Evaluation
Aquatic Receptors	Barium (33)	Moderate	Moderate	Benchmarks developed for the protection of freshwater aquatic life.
(surface water)	Iron (24)	Moderate	Low	USEPA AWQC based primarily on field comparisons of total iron concentrations and presence/absence of a species or community.
	Lead (34)	Moderate	Moderate	Benchmarks developed for the protection of freshwater aquatic life.
Aquatic Receptors	Acenaphthene (30)	Moderate	Low	Screening criterion developed for estuarine and marine sediments.
(sediment)	Dibenzo(a,h)anthracene (13)	Moderate	Low	High detection limit
	Benzo(b)fluoranthene (7)	Low	Low	Benchmark for benzo(k)fluoranthene used.
	2-Methylnaphthalene (7)	Low	Low	Screening criterion developed for estuarine and marine sediments.
	Copper (40)	Moderate	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
Great Blue Heron	Dibenzo(a,h)anthracene (99)	High	Low	High detection limit
	Mercury (89)	High	Low	Relative confidence in the risk evaluation is low since the TRV was derived from mallard chronic LOAEL.

* Relative Contribution to risk is based on the proportion of the HI contributed by the HQ for that group of contaminants (inorganics, SVOCs or pesticides). Both HQs and HI used were based on average contaminant concentrations for each soil group. Relative contributions were assigned as follows:
Low = HQ is < 10% of HI
Moderate = HQ is 10% - 50% of HI
High = HQ is > 50% of HI

TABLE 7-52. SUMMARY OF RELATIVE CONTRIBUTION OF CONTAMINANTS TO ECOLOGICAL RISK AND ASSOCIATED UNCERTAINTY AT RICHARDSON POND GROUP.

Endpoint	Contaminant (%HQ of HI)	Relative Contribution to Risk*	Relative Confidence in Risk Evaluation	Comment on Risk Evaluation
Aquatic Receptors	Barium (20)	Moderate	Moderate	Benchmarks developed for the protection of freshwater aquatic life.
(surface water)	Iron (15)	Moderate	Low	USEPA AWQC based primarily on field comparisons of total iron concentrations and presence/absence of a species or community.
	Lead (19)	Moderate	Moderate	Benchmarks developed for the protection of freshwater aquatic life.
Aquatic Receptors	Acenaphthene (40)	Moderate	Low	Screening criterion developed for estuarine and marine sediments.
(sediment)	Anthracene (3)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	Benzo(a)anthrancene (3)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	Benzo(a)pyrene (2)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	Benzo(b)fluoranthene (3)	Low	Low	Benchmark for benzo(k)fluoranthene used.
	Benzo(g,h,i)perylene (4)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	Benzo(k)fluoranthene (3)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	Butylbenzylphthalate (3)	Low	Low	High detection limit
	Chrysene (2)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.

Endpoint	Contaminant (%HQ of HI)	Relative Contribution to Risk*	Relative Confidence in Risk Evaluation	Comment on Risk Evaluation
	Dibenzo(a,h)anthracene (10)	Moderate	Low	High detection limit
	Fluoranthene (1)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	Fluorene (3)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	Indeno(1,2,3-cd)pyrene (3)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	2-Methylnaphthalene (10)	Moderate	Low	High detection limit
	Naphthalene (4)	Low	Low	High detection limt
	Phenanthrene (3)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
	Pyrene (3)	Low	Moderate	Benchmark developed to represent effects on sediment-dwelling organisms in freshwater.
Great Blue Heron	Dibenzo(a,h)anthracene (99)	High	Low	High detection limit
	Zinc (71)	High	Low	Relative confidence in risk evaluation is low since the TRV was based on a mallard subchronic LOAEL.

* Relative Contribution to risk is based on the proportion of the HI contributed by the HQ for that group of contaminants (inorganics, SVOCs or pesticides). Both HQs and HI used were based on average contaminant concentrations for each soil group. Relative contributions were assigned as follows:
Low = HQ is < 10% of HI
Moderate = HQ is 10% - 50% of HI
High = HQ is > 50% of HI

TABLE 7-53. SUMMARY OF RELATIVE CONTRIBUTION OF CONTAMINANTS TO ECOLOGICAL RISK AND ASSOCIATED UNCERTAINTY AT CONTENT BROOK WETLAND GROUP.

Endpoint	Contaminant (%HQ of HI)	Relative Contribution to Risk*	Relative Confidence in Risk Evaluation	Comment on Risk Evaluation
Aquatic Receptors	Aluminum (12)	Moderate	Low	Benchmarks developed for the protection of freshwater aquatic life. Criterion based on fish that do not inhabit the site.
(surface water)	Arsenic (1)	Low	Moderate	Benchmarks developed for the protection of freshwater aquatic life.
	Barium (50)	Moderate	Moderate	Benchmarks developed for the protection of freshwater aquatic life.
	Iron (30)	Moderate	Low	USEPA AWQC based primarily on field comparisons of total iron concentrations and presence/absence of a species or community.
	Manganese (4)	Low	Moderate	Benchmarks developed for the protection of freshwater aquatic life.
	Silver (4)	Low	Moderate	Benchmarks developed for the protection of freshwater aquatic life.
Aquatic Receptors (sediment)	Acenaphthene (45)	Moderate	Low	High detection limit
Great Blue Heron	Dibenzo(a,h)anthracene (99)	High	Low	Relative confidence in the risk evalution is low since the TRV was derived from a rat chronic LOAEL.

* Relative Contribution to risk is based on the proportion of the HI contributed by the HQ for that group of contaminants (inorganics, SVOCs or pesticides). Both HQs and HI used were based on average contaminant concentrations for each soil group. Relative contributions were assigned as follows:
Low = HQ is < 10% of HI
Moderate = HQ is 10% - 50% of HI
High = HQ is > 50% of HI

EPA Contract No. 68-W9-0036
EPA Work Assignment No. 36-1L57

EPA Deputy Project Officer: Filomena DiNardo
EPA Remedial Project Manager: Donald McElroy

REMEDIAL INVESTIGATION FINAL REPORT

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Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, Massachusetts

September 1997

Metcalf & Eddy
An Air & Water Technologies Company

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North Billerica, Massachusetts

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An Air & Water Technologies Company

LIST OF FIGURES

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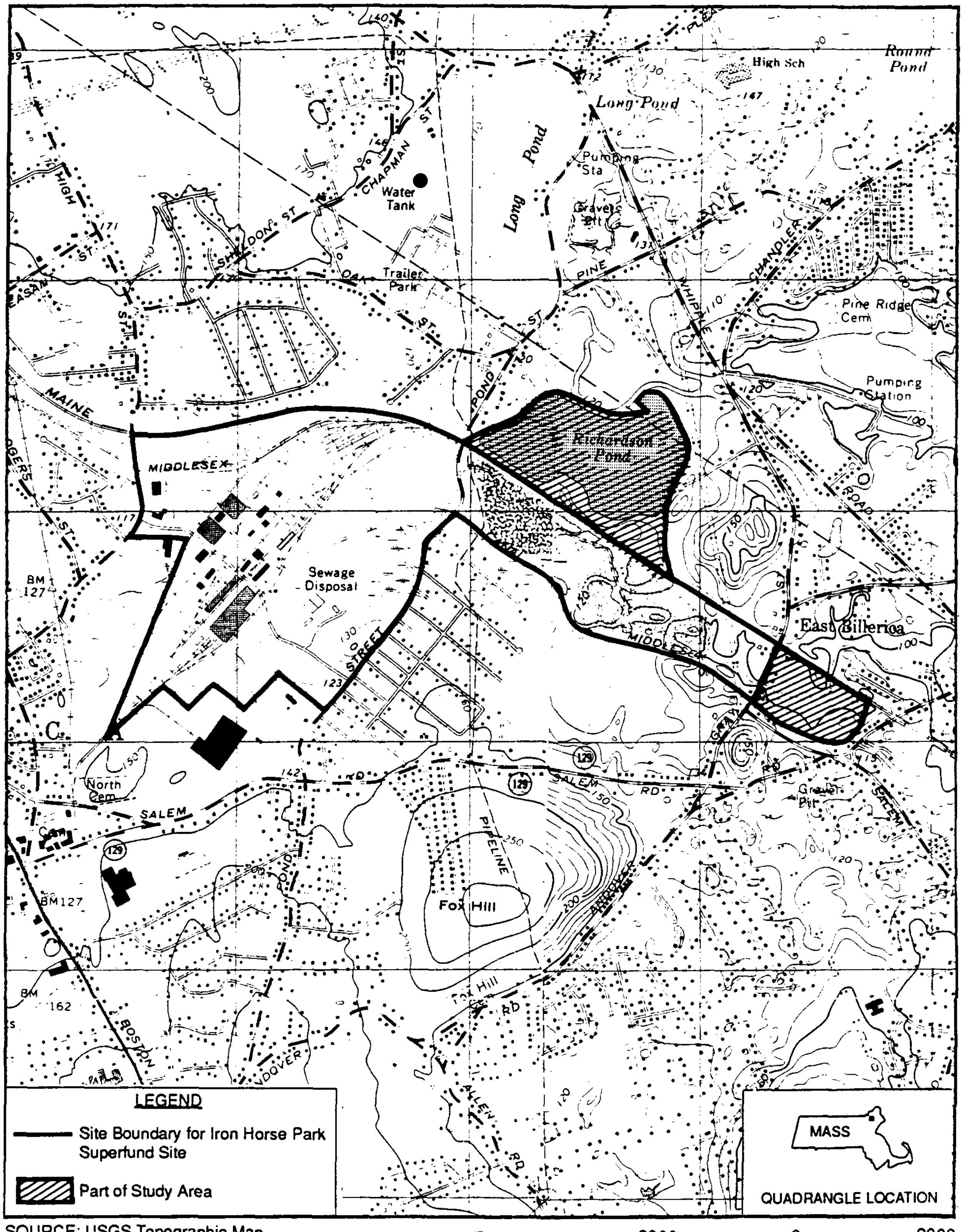
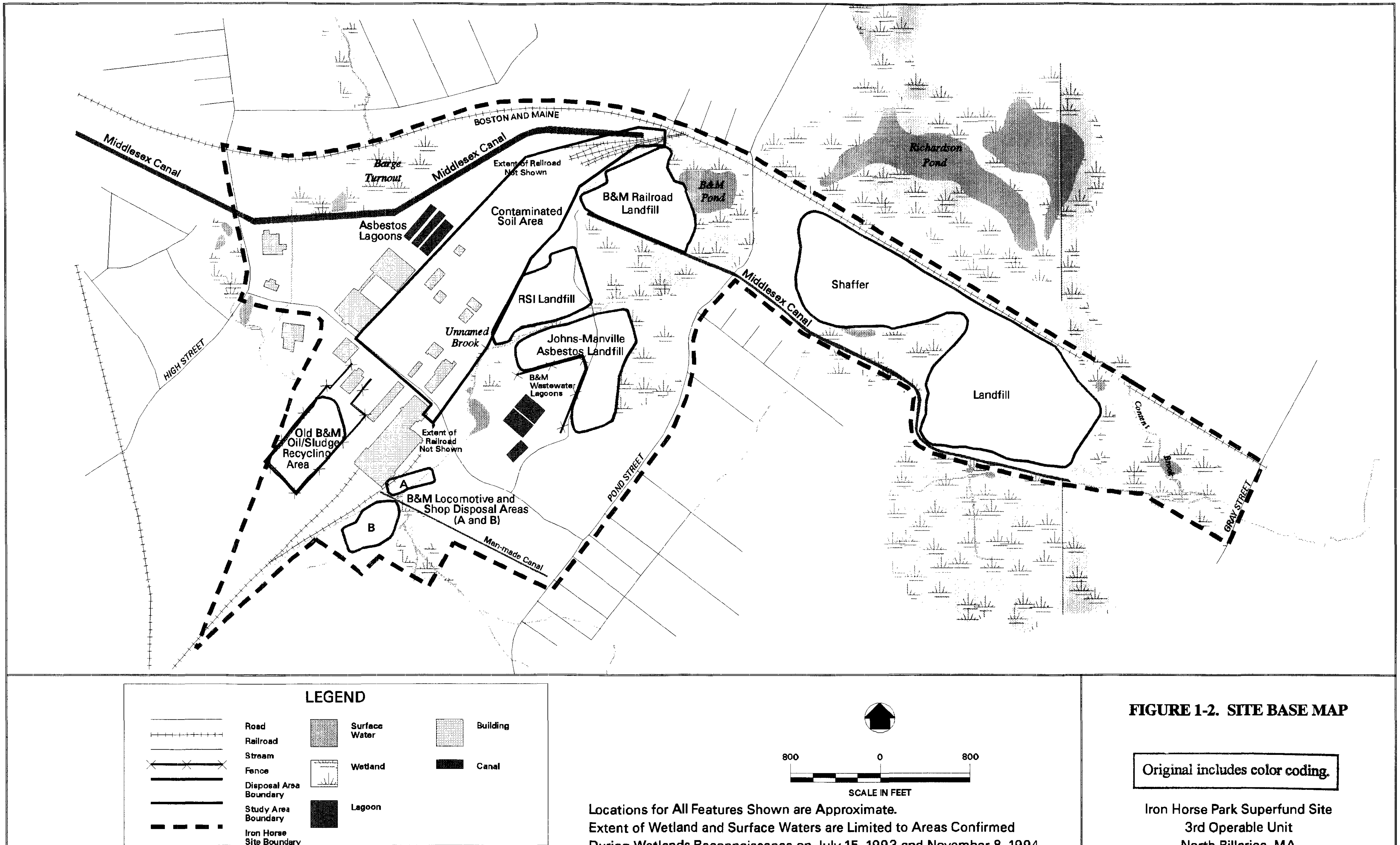


SOURCE: USGS Topographic Map
Billerica, MA N4230-W7115/7.5 (1979)
Wilmington, MA N4230-W7107.5/7.5 (1979)

2000 0 2000
SCALE IN FEET

FIGURE 1-1. GEOGRAPHICAL LOCATION OF THE IRON HORSE PARK SUPERFUND SITE



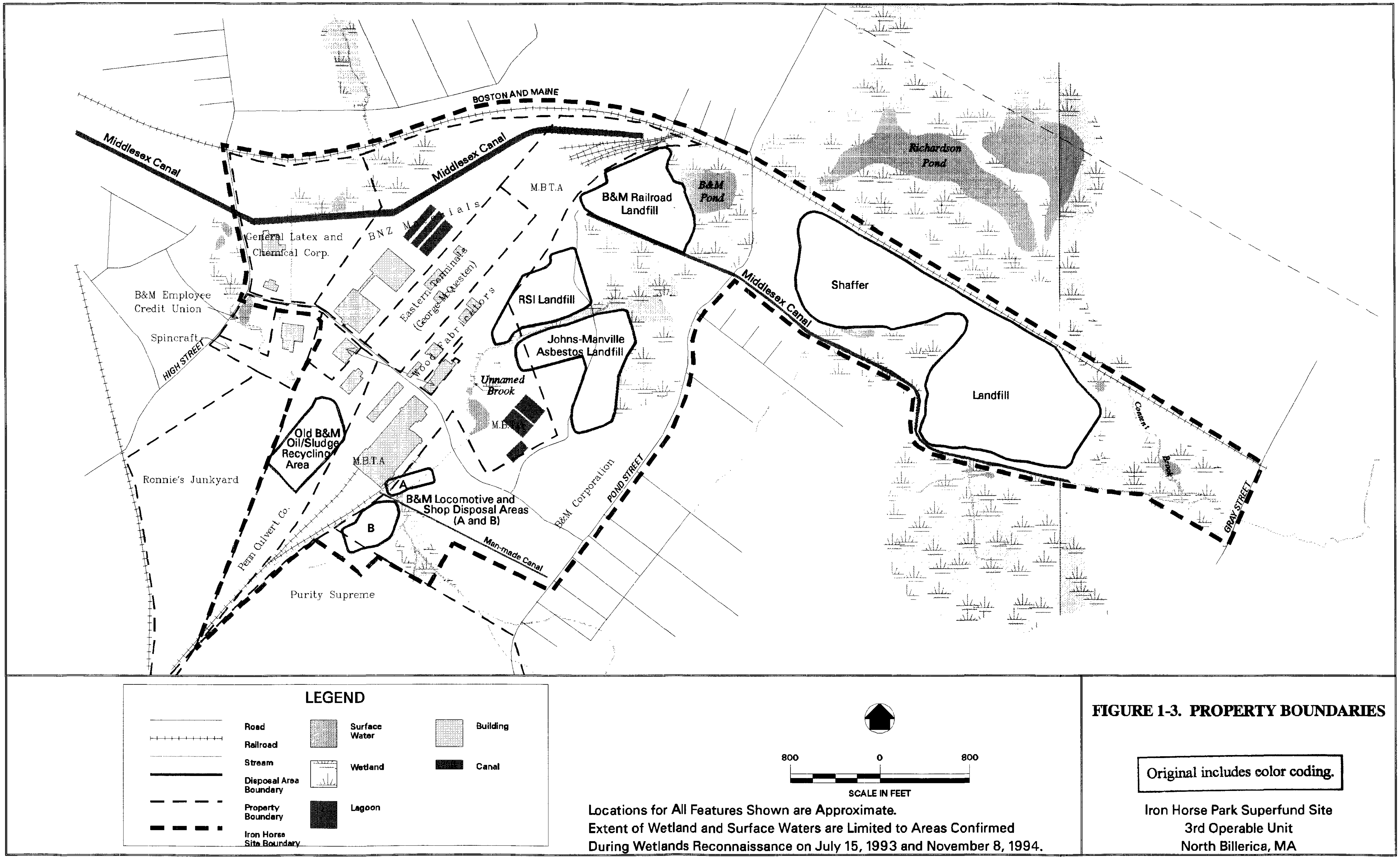
Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

FIGURE 1-2. SITE BASE MAP

Original includes color coding.

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

fig1-a.aml July 1996



Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

FIGURE 1-3. PROPERTY BOUNDARIES

Original includes color coding.

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

prop.aml July 1996

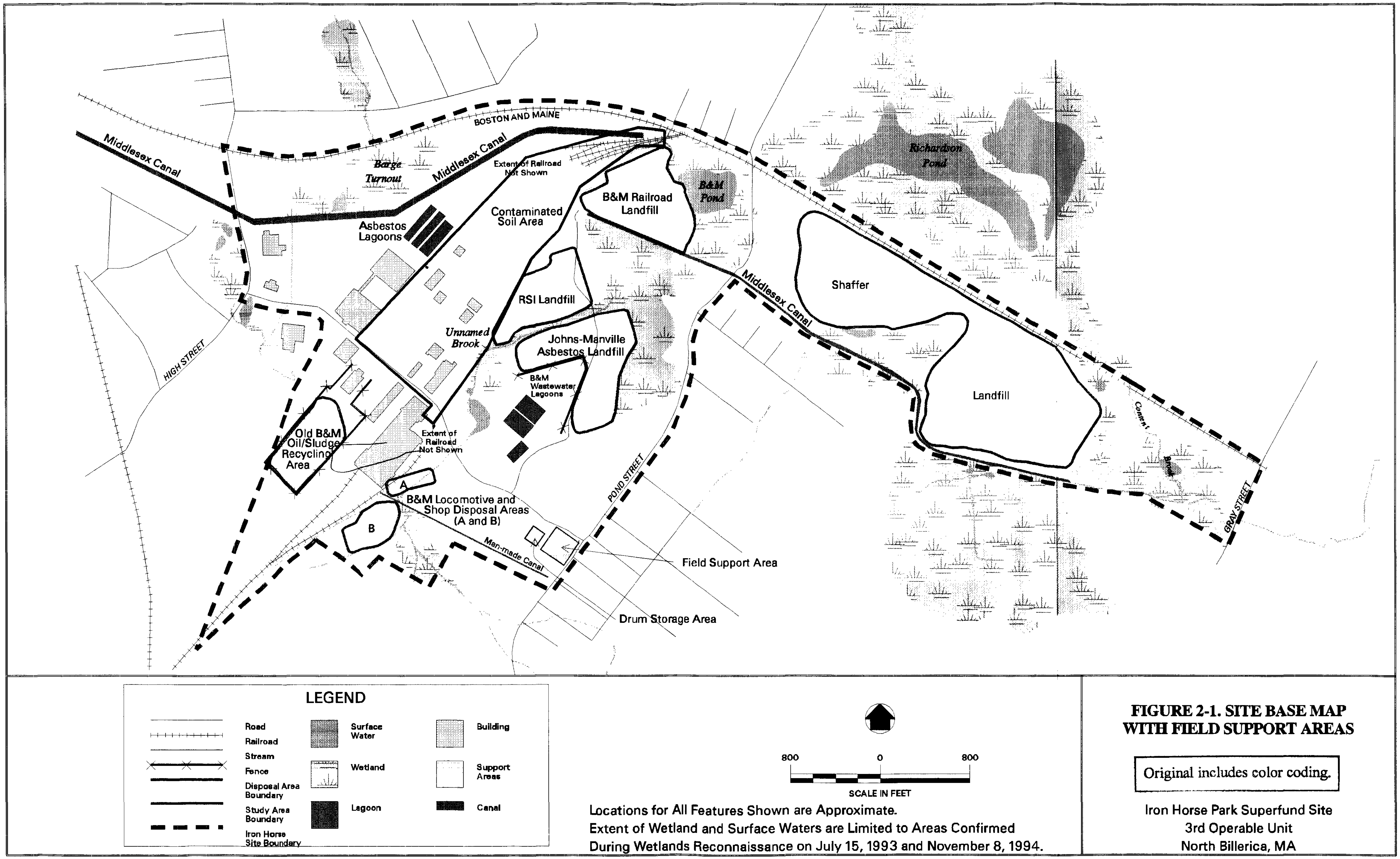


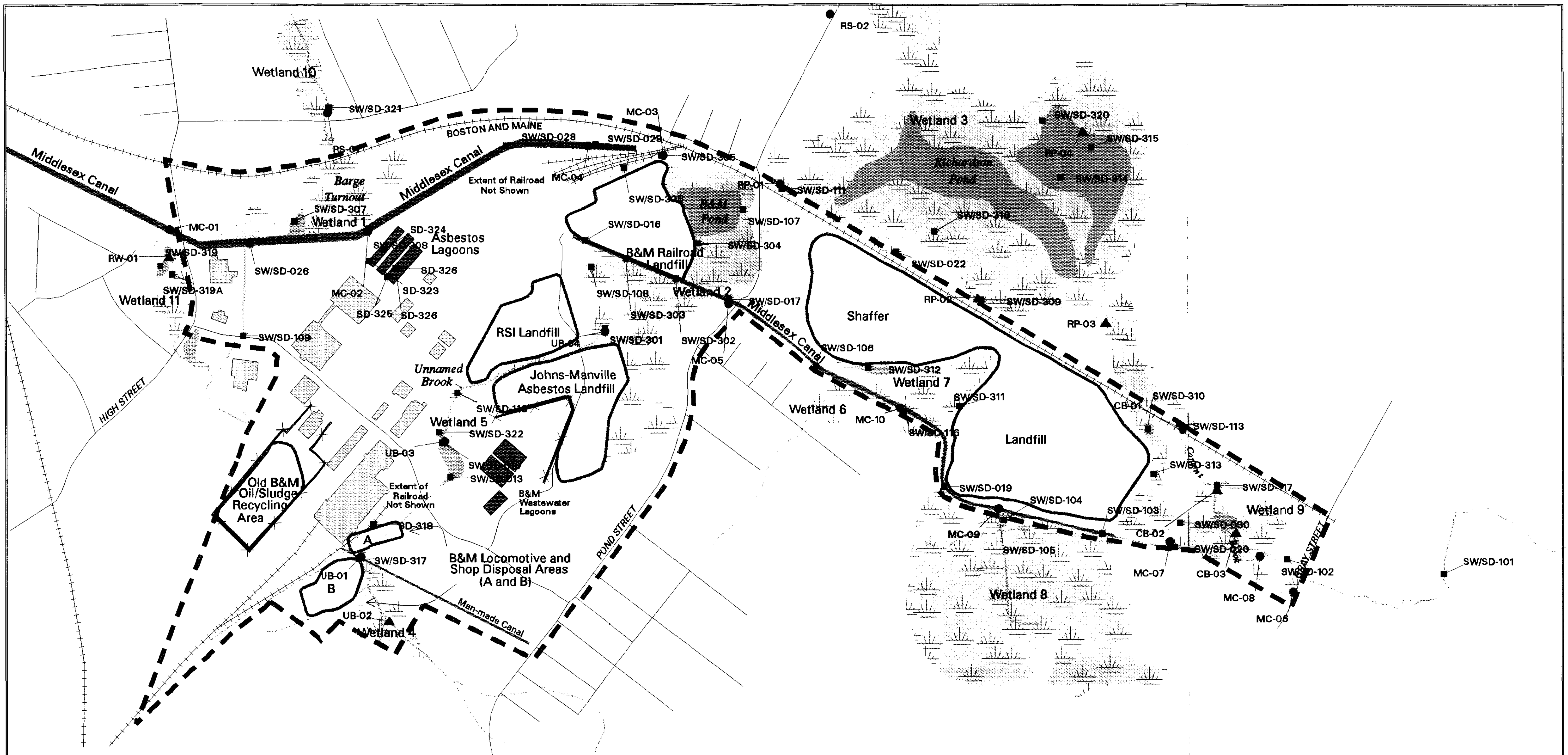
FIGURE 2-1. SITE BASE MAP WITH FIELD SUPPORT AREAS

Original includes color coding.

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

base196.aml July 1996

Metcalf & Eddy



LEGEND

Road	Surface Water	Building	Surface Water/ Sediment Station
Railroad	Wetland	Canal	Lotic Station
Stream	Lagoon		Lotic Reference Station
Fence			Lentic Station
Disposal Area Boundary			Lentic Reference Station
Iron Horse Site Boundary			

800 0 800

SCALE IN FEET

Locations for All Features Shown are Approximate. Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

FIGURE 2-2.
LOCATION OF
BENTHIC INVERTEBRATE AND SEDIMENT SAMPLING LOCATIONS

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

wetbenth.aml July 1996

Original includes color coding.

Metcalf & Eddy

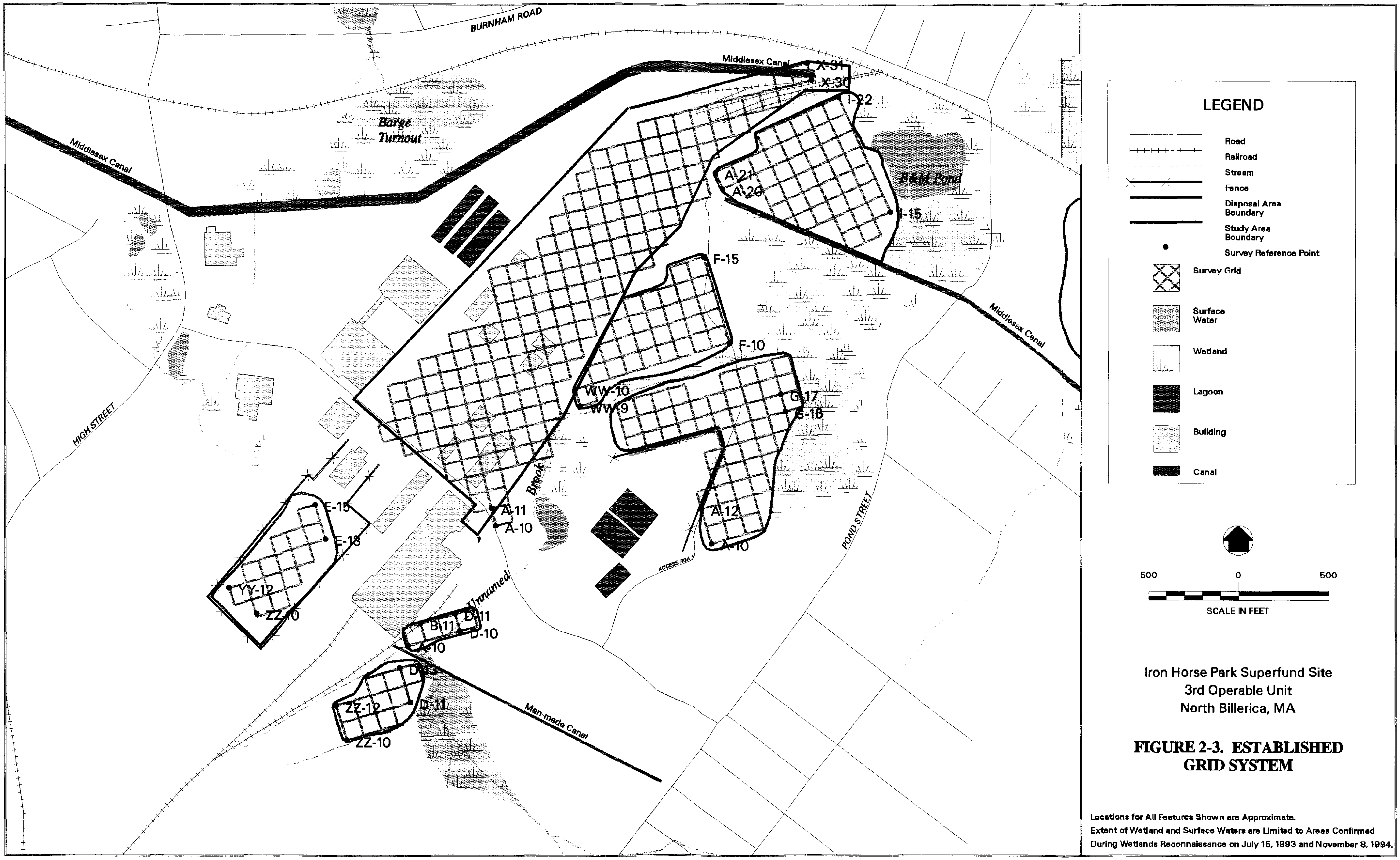
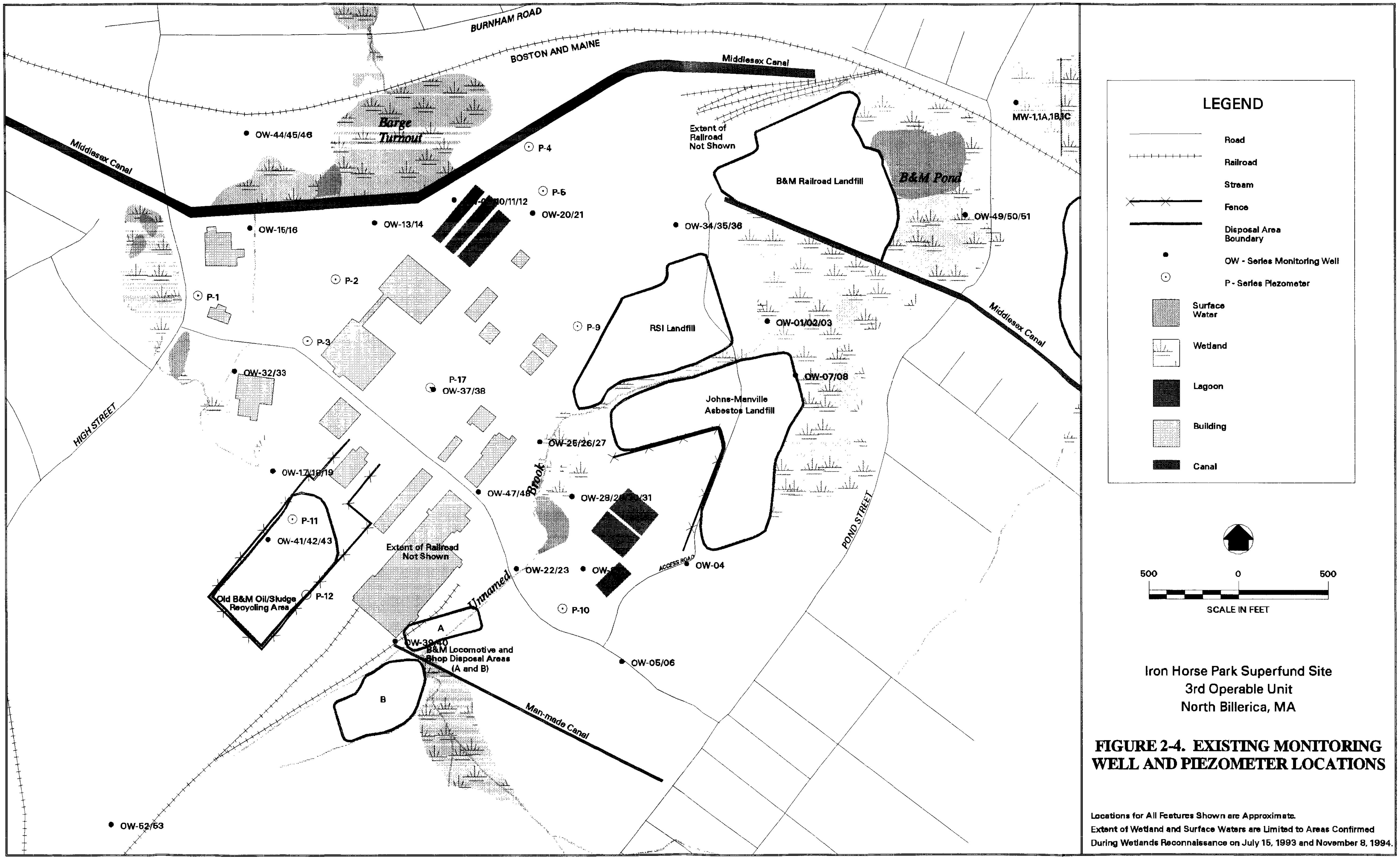


FIGURE 2-3. ESTABLISHED GRID SYSTEM

sitegrid.aml July 1996

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

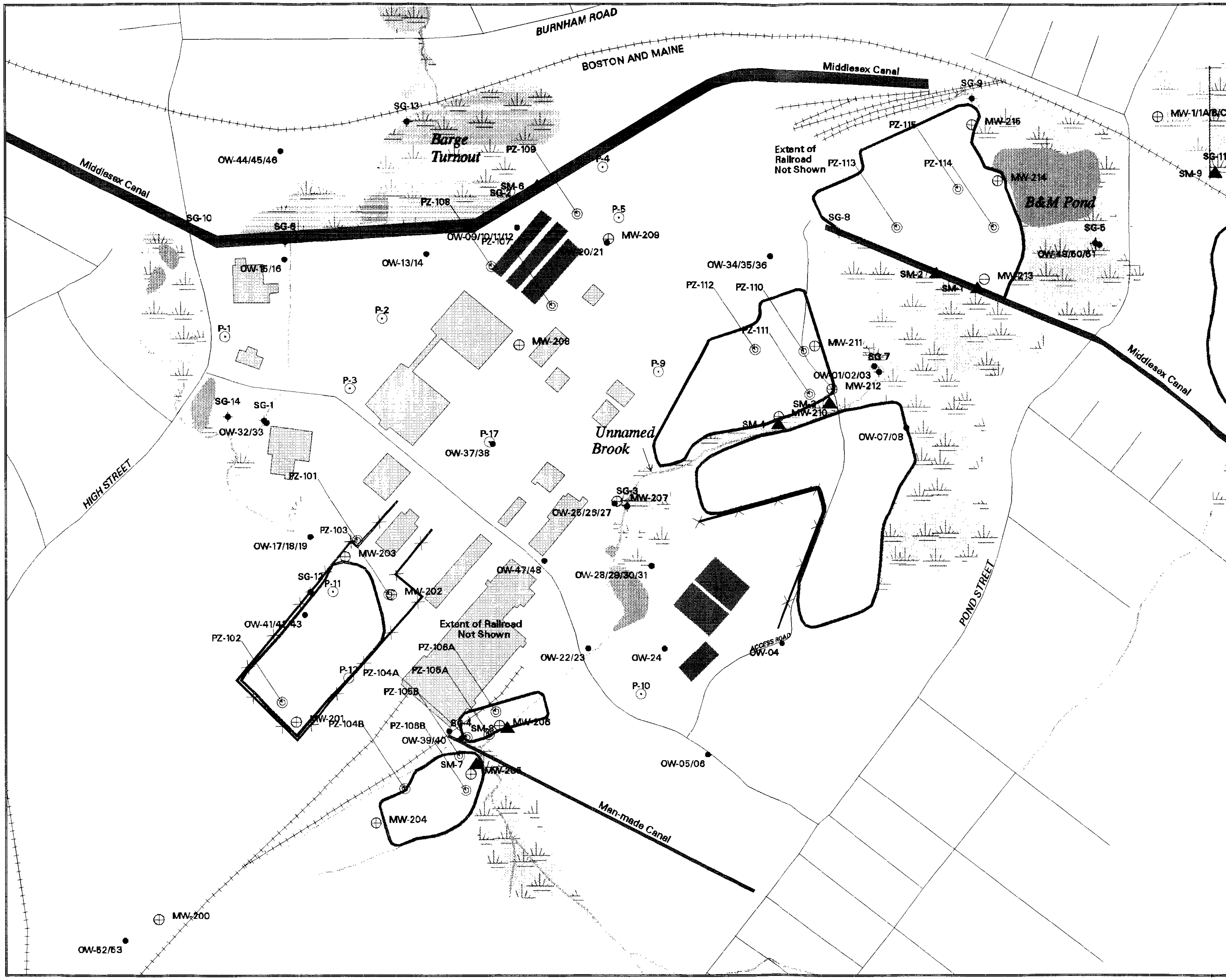
FIGURE 2-4. EXISTING MONITORING WELL AND PIEZOMETER LOCATIONS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

fig2-d.aml July 1996

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

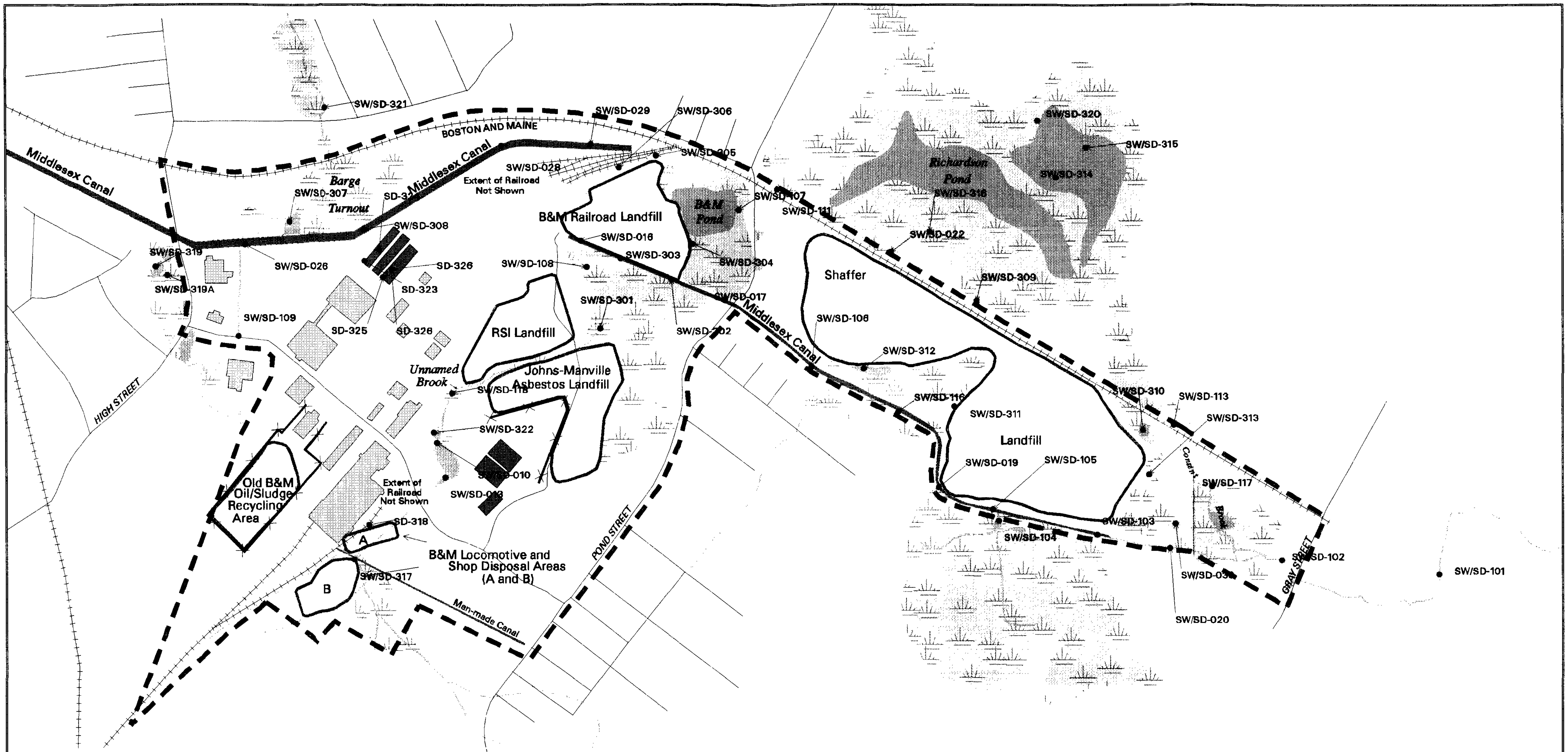
FIGURE 2-5. NEW AND EXISTING MONITORING WELL, PIEZOMETER, STAFF GAUGE, AND SEEPAGE METER LOCATIONS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

fig2-d1.aml July 1996

Original includes color coding.

Metcalf & Eddy



LEGEND

- Road
- Railroad
- Stream
- Fence
- Disposal Area Boundary
- Iron Horse Site Boundary
- Surface Water
- Wetland
- Lagoon
- Building
- Canal
- Surface Water/ Sediment Station

800 0 800

SCALE IN FEET

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

FIGURE 2-6. SITE-WIDE SURFACE WATER / SEDIMENT SAMPLING LOCATIONS

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

joaswsd95.aml July 1996

Original includes color coding.

Metcalf & Eddy

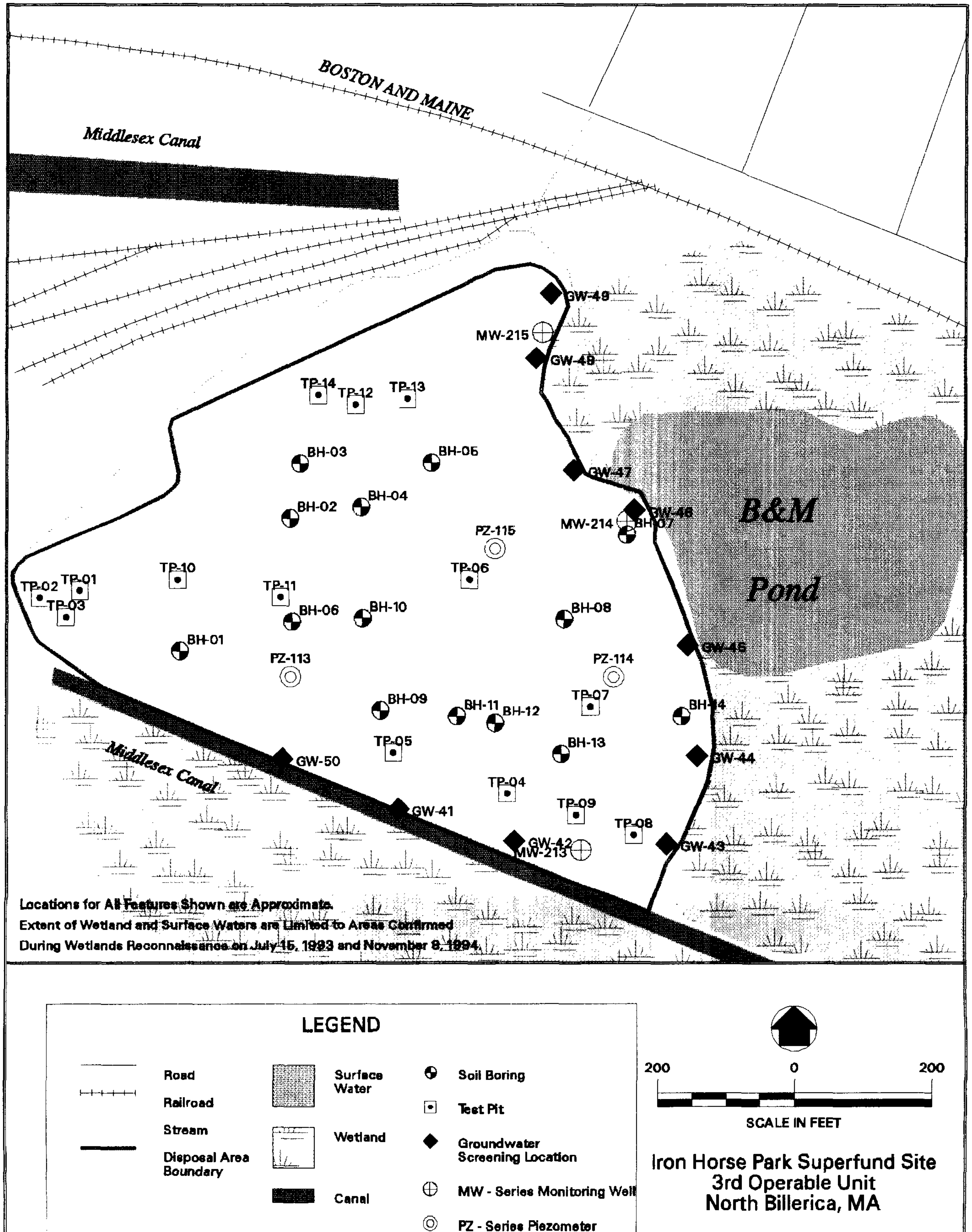


FIGURE 2-7. SUBSURFACE INVESTIGATION LOCATIONS IN THE B&M RAILROAD LANDFILL

fig2-j.aml July 1996

Original includes color coding.

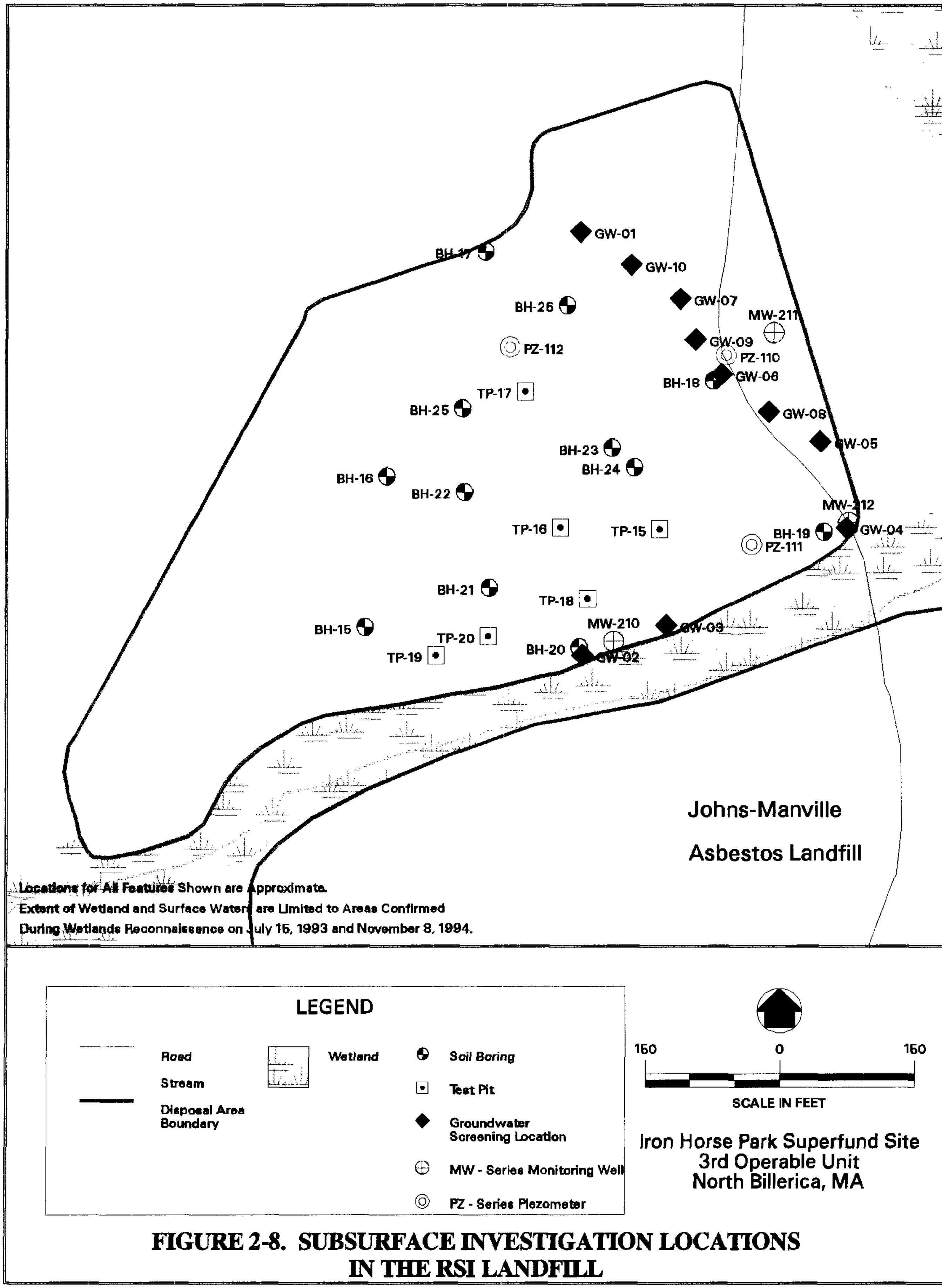


FIGURE 2-8. SUBSURFACE INVESTIGATION LOCATIONS IN THE RSI LANDFILL

fig2-k.aml July 1996

Original includes color coding.

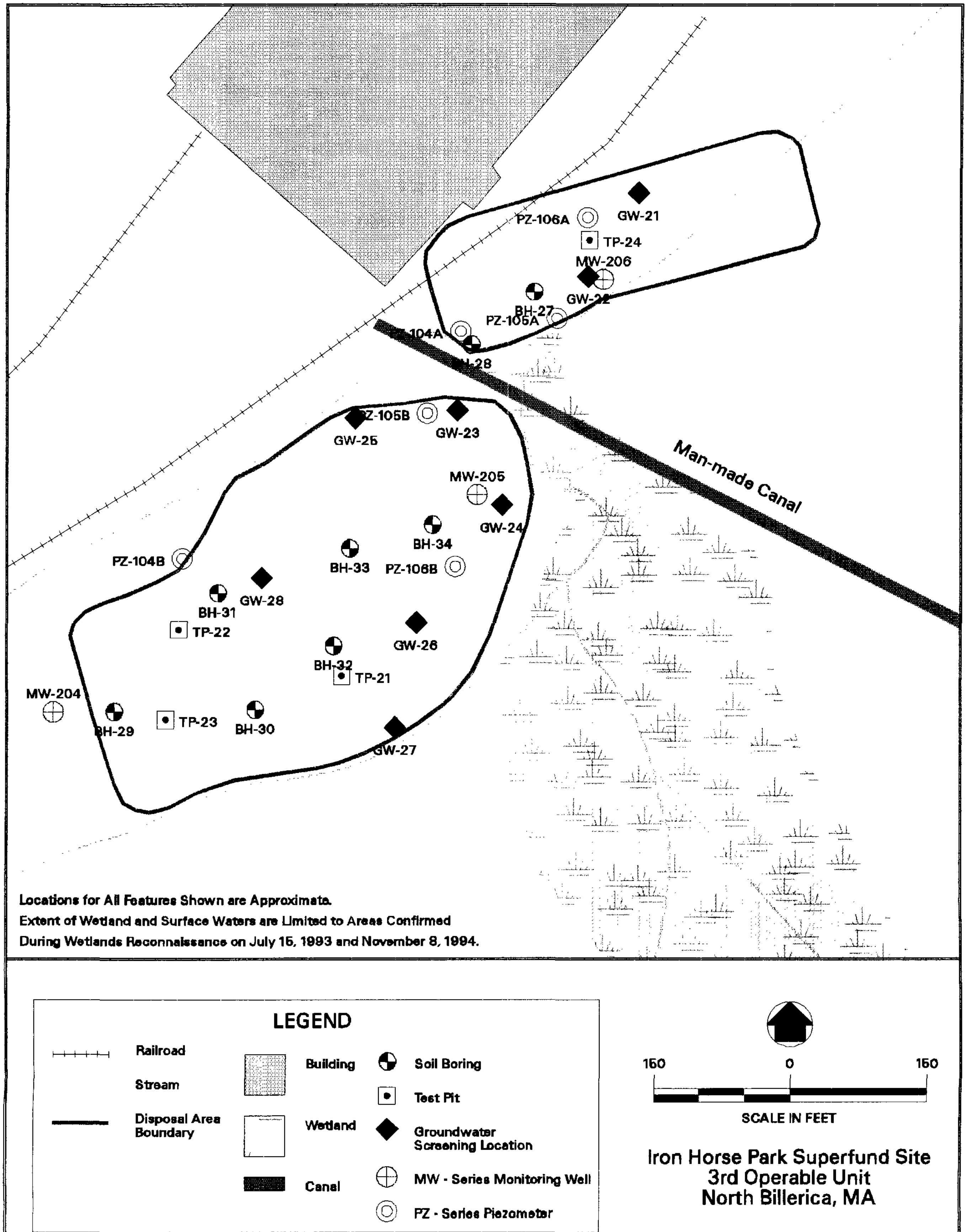


FIGURE 2-9. SUBSURFACE INVESTIGATION LOCATIONS IN THE B&M LOCOMOTIVE SHOP DISPOSAL AREAS

fig2-l.aml July 1996

Original includes color coding.

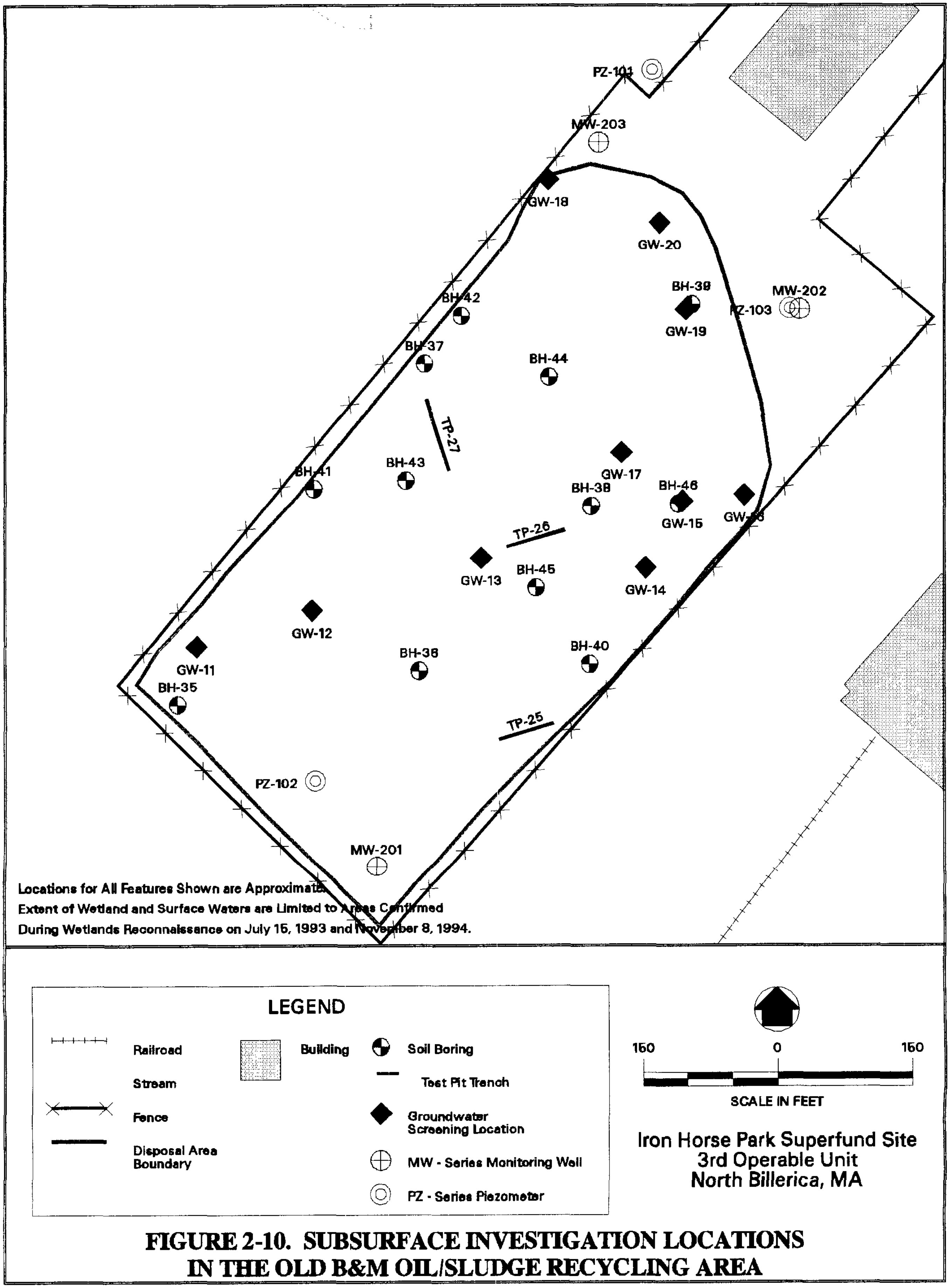


FIGURE 2-10. SUBSURFACE INVESTIGATION LOCATIONS IN THE OLD B&M OIL/SLUDGE RECYCLING AREA

fig2-m.aml July 1996

Original includes color coding.

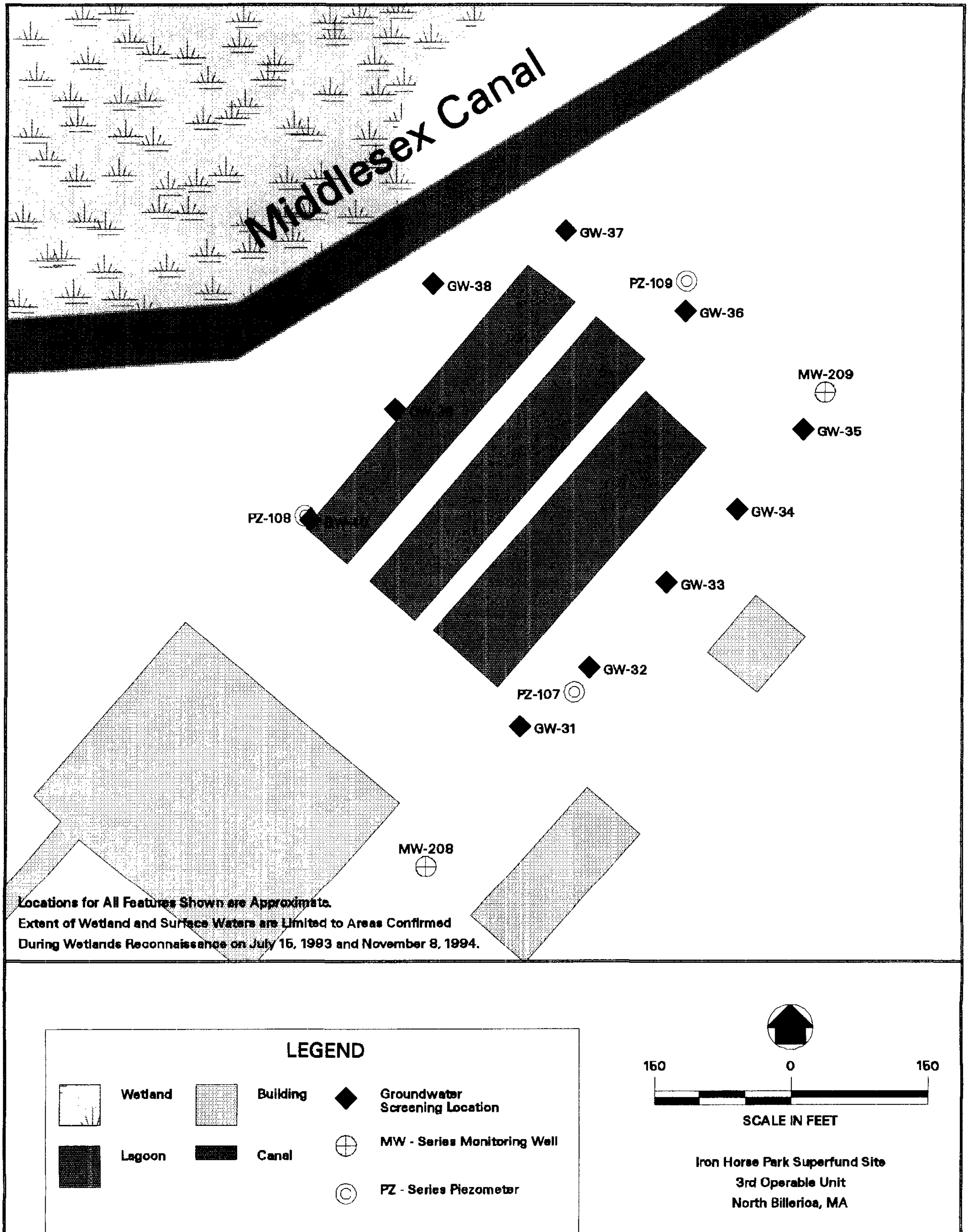


FIGURE 2-11. SUBSURFACE INVESTIGATION LOCATIONS IN THE ASBESTOS LAGOONS

figm2.aml July 1996

Original includes color coding.

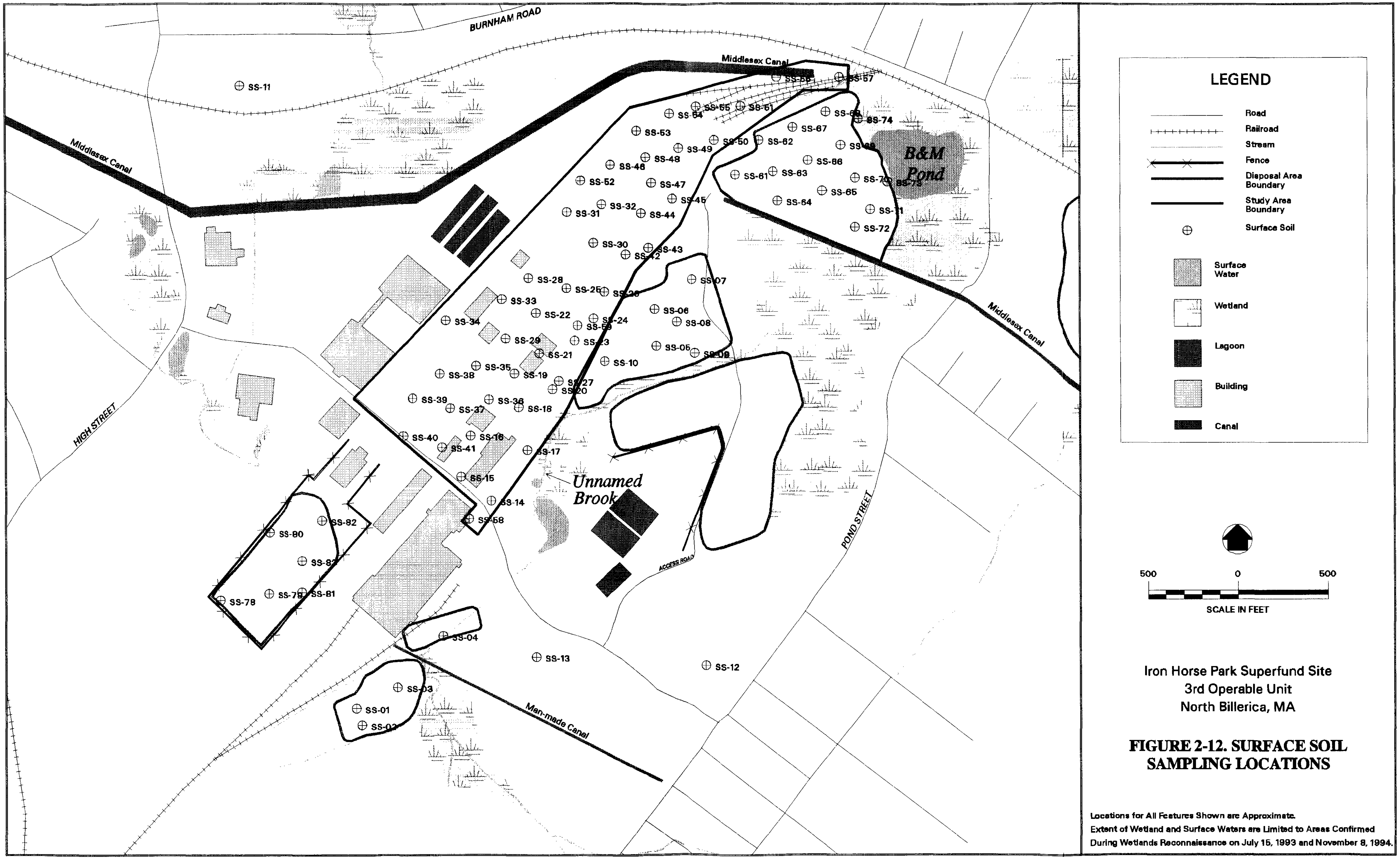


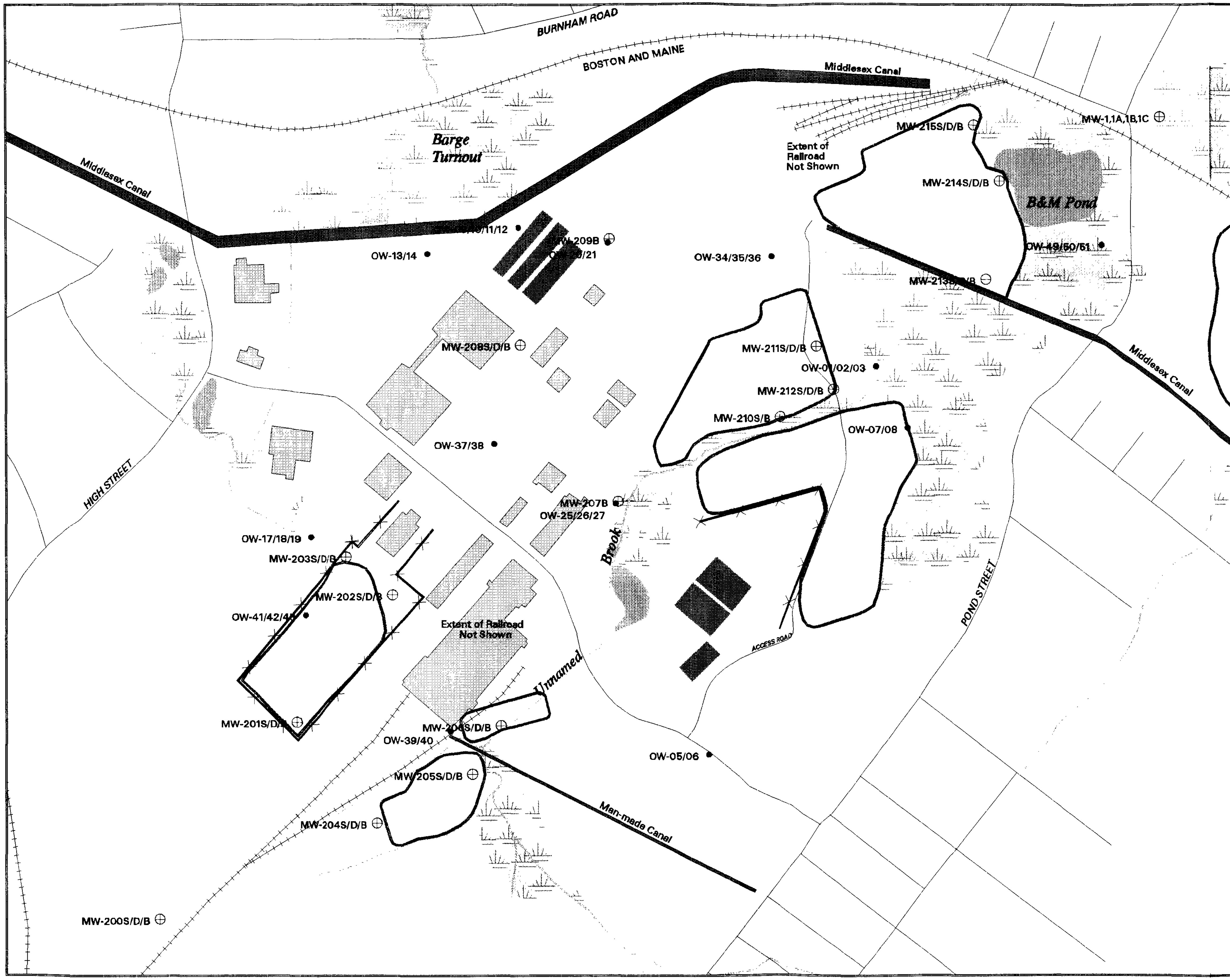
FIGURE 2-12. SURFACE SOIL SAMPLING LOCATIONS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

fig2-n.aml July 1996

Original includes color coding.

Metcalf & Eddy



LEGEND

- Road
- Railroad
- Stream
- Fence
- Disposal Area Boundary
- MW - Series Monitoring Well
- OW - Series Monitoring Well
- Surface Water
- Wetland
- Lagoon
- Building
- Canal

No groundwater samples were collected from MW-1, MW-1A, MW-1B, or OW-06 due to the wells being dry at the time of sampling.

500 0 500

SCALE IN FEET

Iron Horse Park Superfund Site
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North Billerica, MA

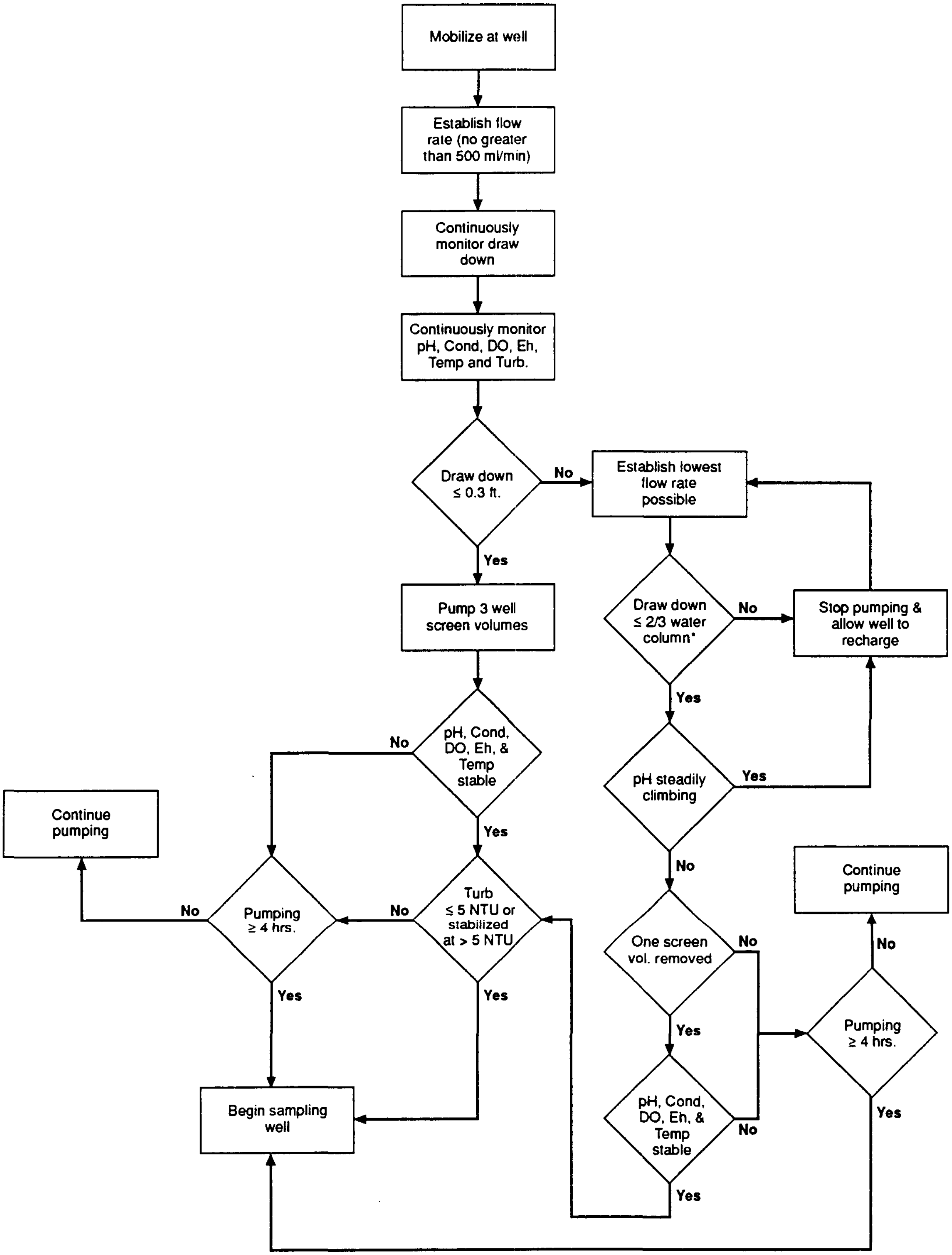
FIGURE 2-13. MONITORING WELL SAMPLING LOCATIONS, MARCH AND JULY 1995

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

fig2-y.aml July 1996

Original includes color coding.

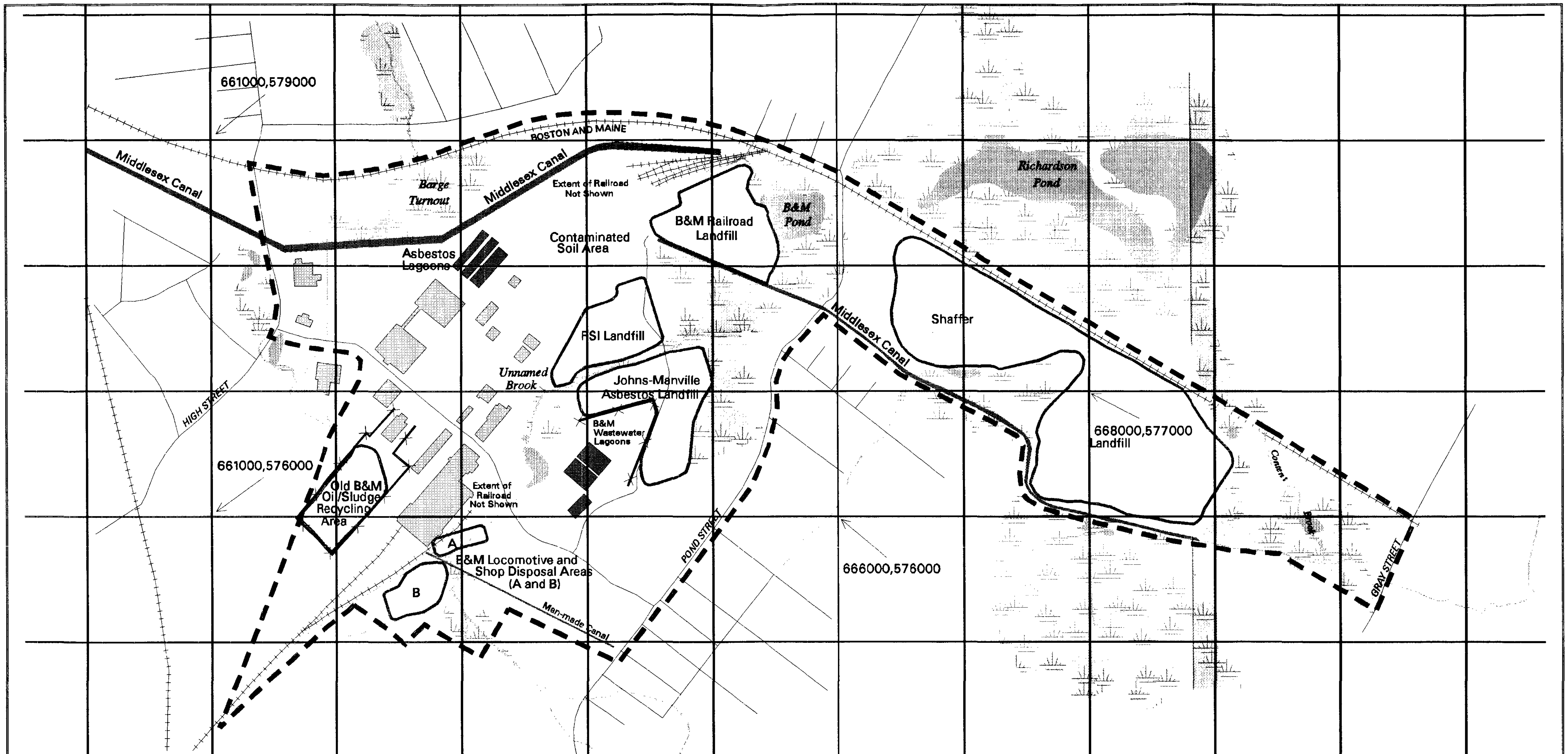
Metcalf & Eddy

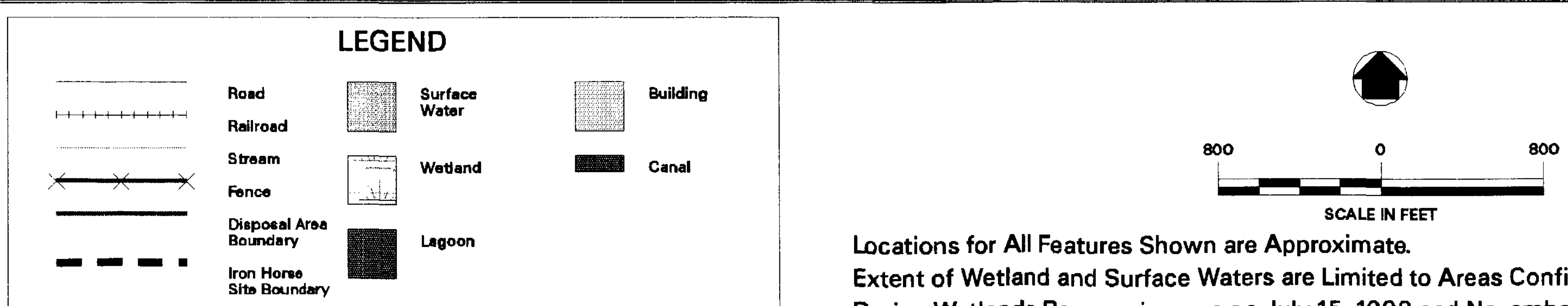


NOTE: * Based on water column above well screen

FIGURE 2-14. LOW-FLOW SAMPLING DECISION FLOWCHART

5052/TK
Metcalf & Eddy





Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

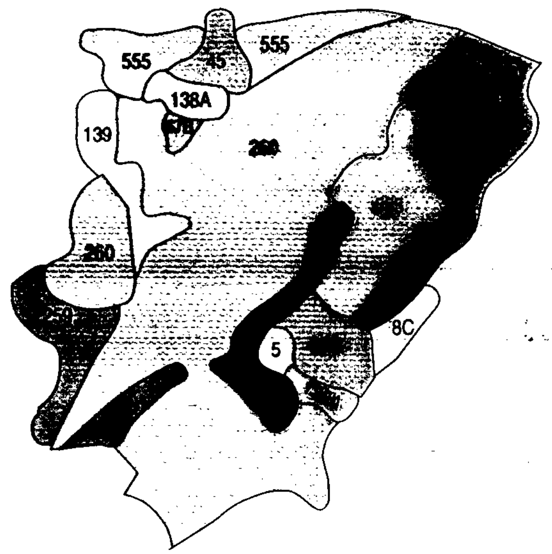
FIGURE 2-15. SITE BASE MAP WITH STATE PLANE COORDINATE GRID

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

epcgrid.aml July 1996

Original includes color coding.

Metcalf & Eddy



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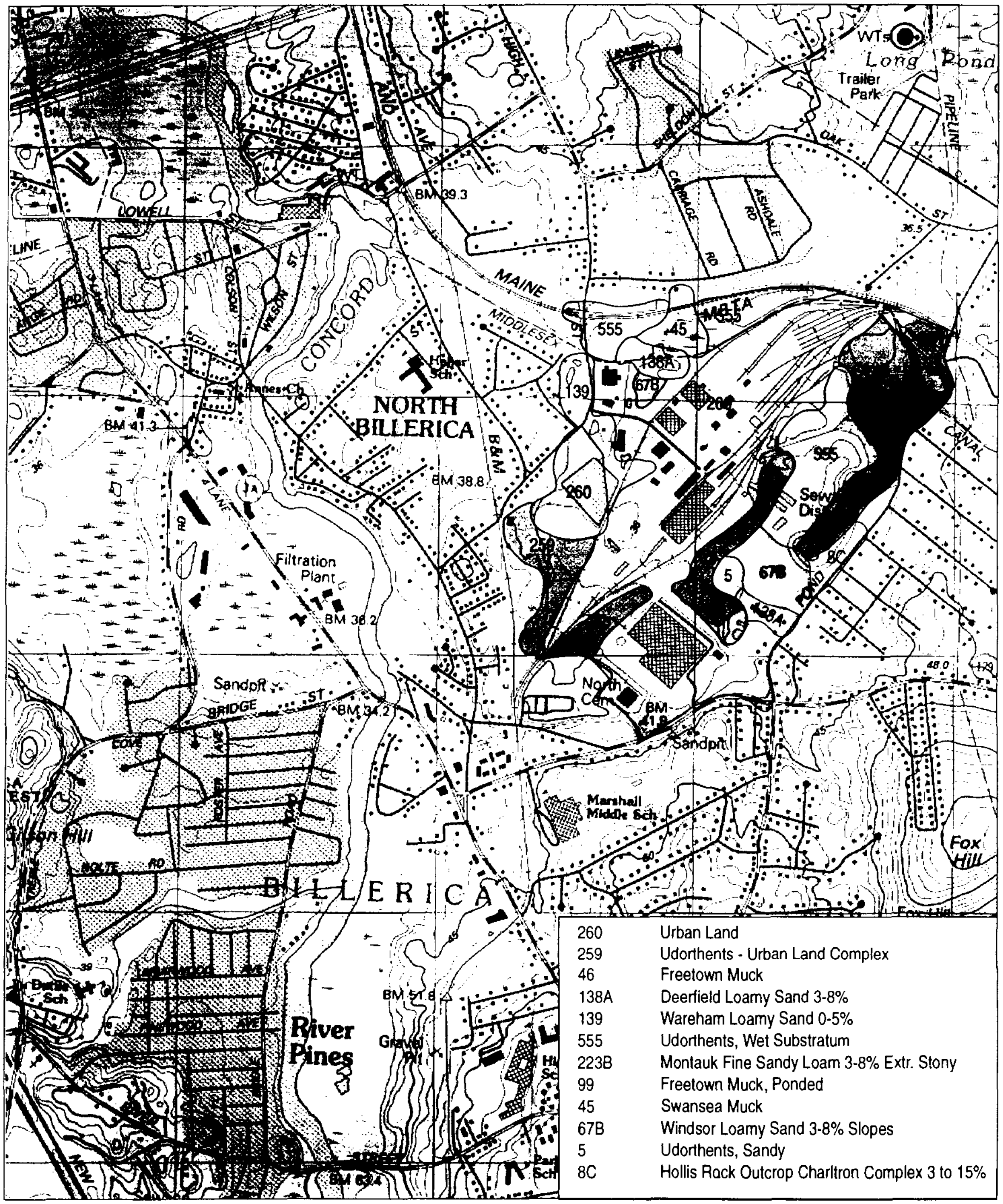


SOURCE: USGS TOPOGRAPHIC MAP
BILLERICA, MA., 1987

5053jp

2000 0 2000

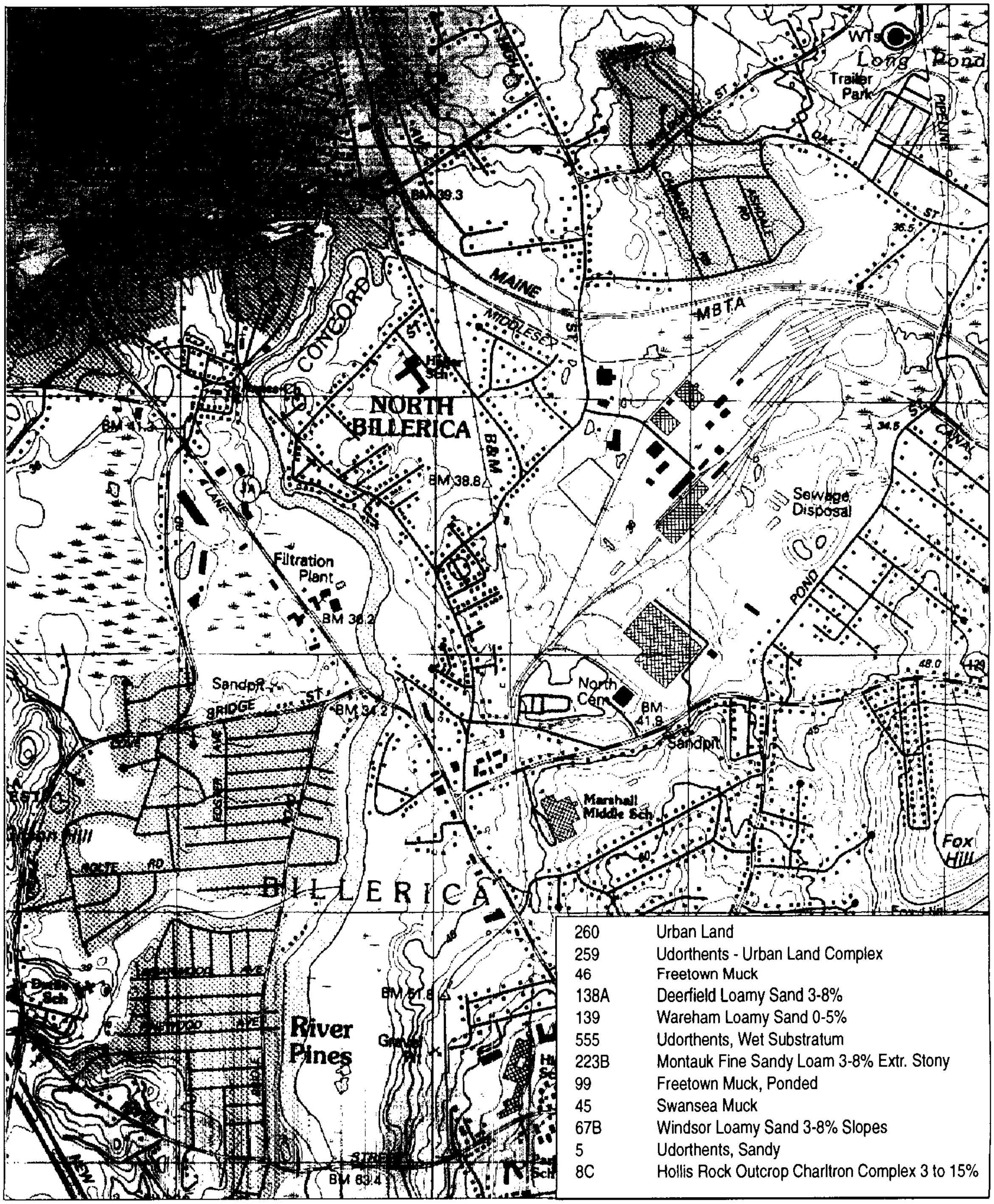
SCALE IN FEET

FIGURE 3-1. SOIL TYPES

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

Original includes color coding.

Originals in color.



SOURCE: USGS TOPOGRAPHIC MAP
BILLERICA, MA., 1987

5053jp

2000 0 2000

SCALE IN FEET

FIGURE 3-1. SOIL TYPES

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

Originals in color.

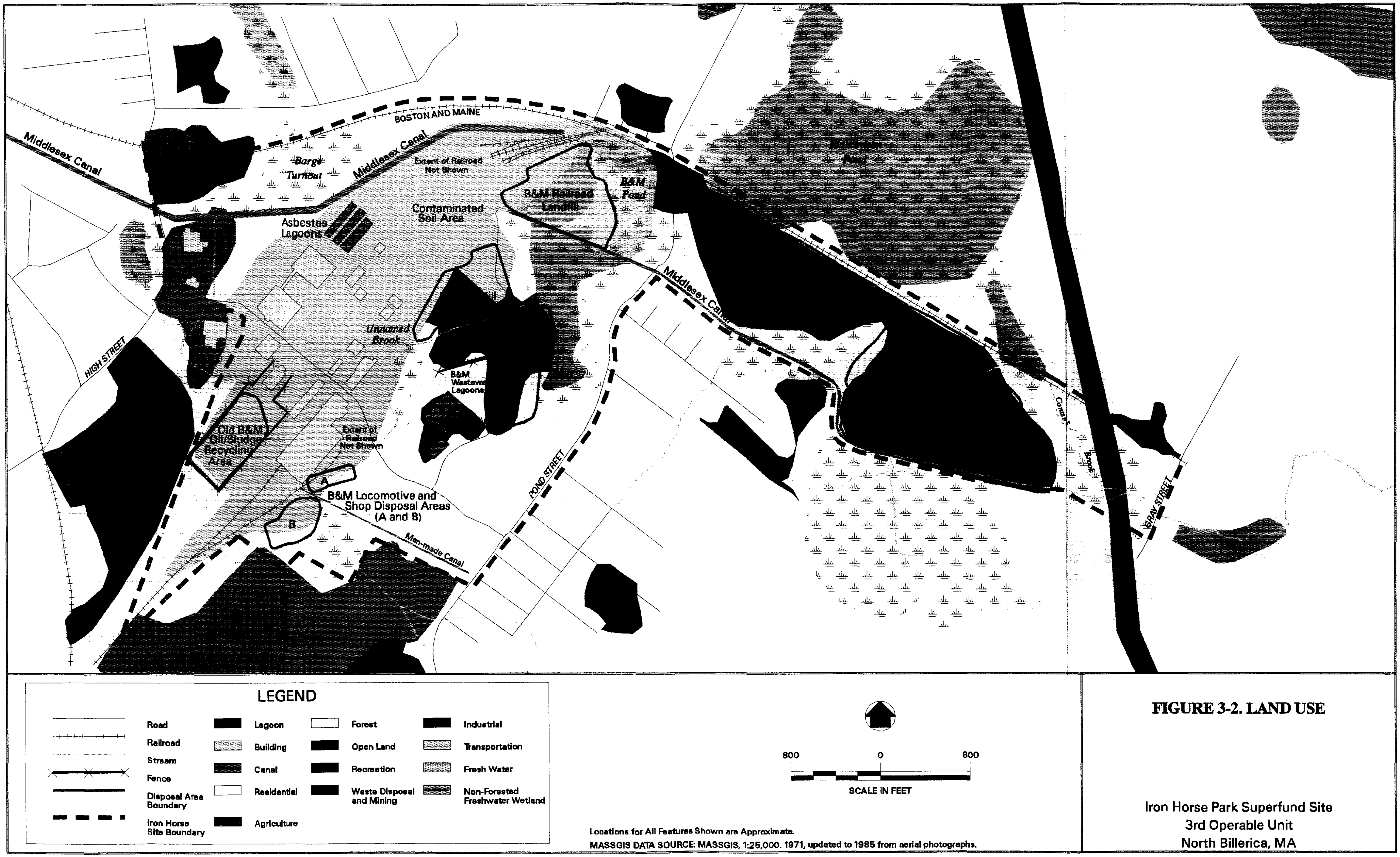


FIGURE 3-2. LAND USE

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

landuse.aml July 1996

Original includes color coding.

Metcalf & Eddy

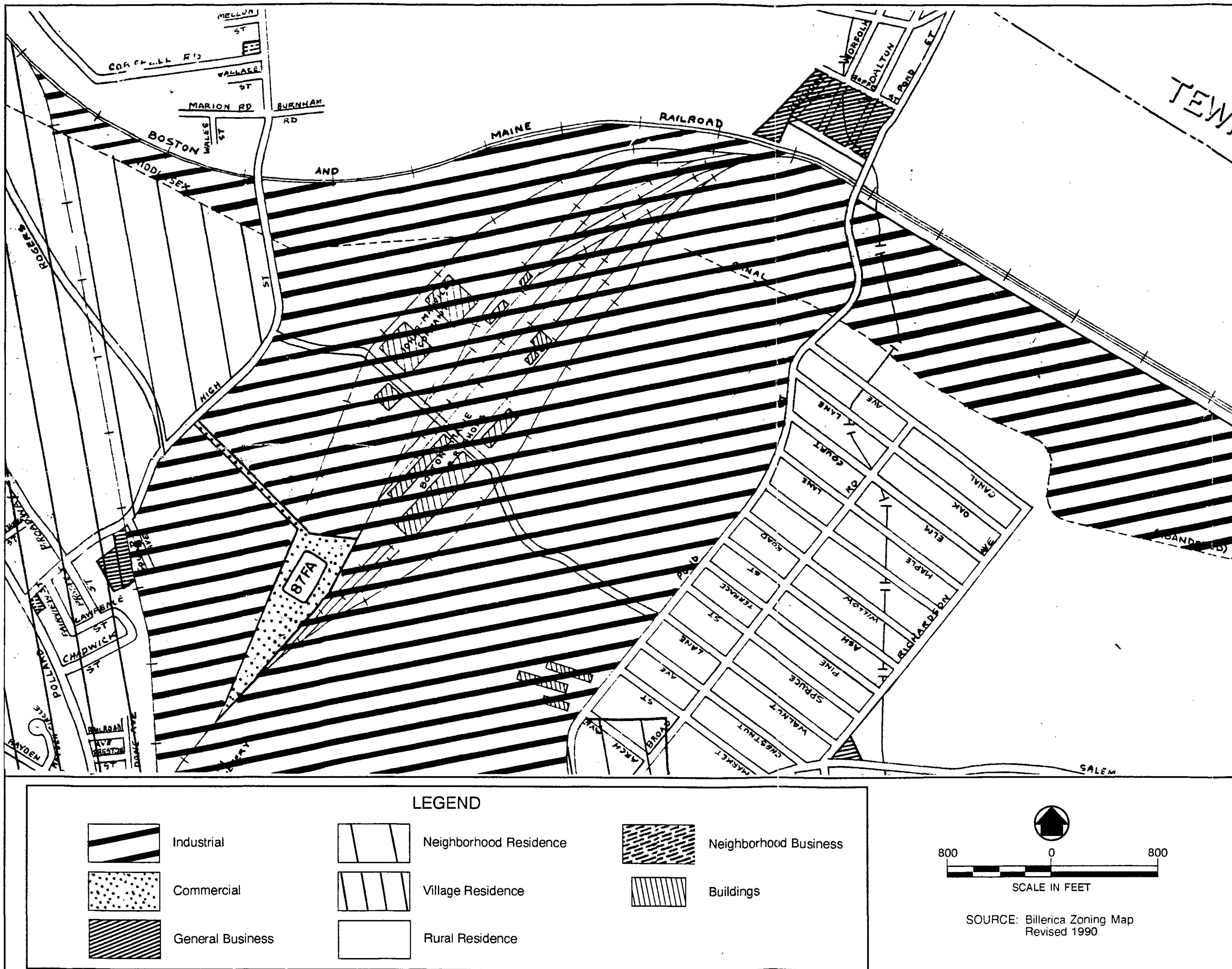
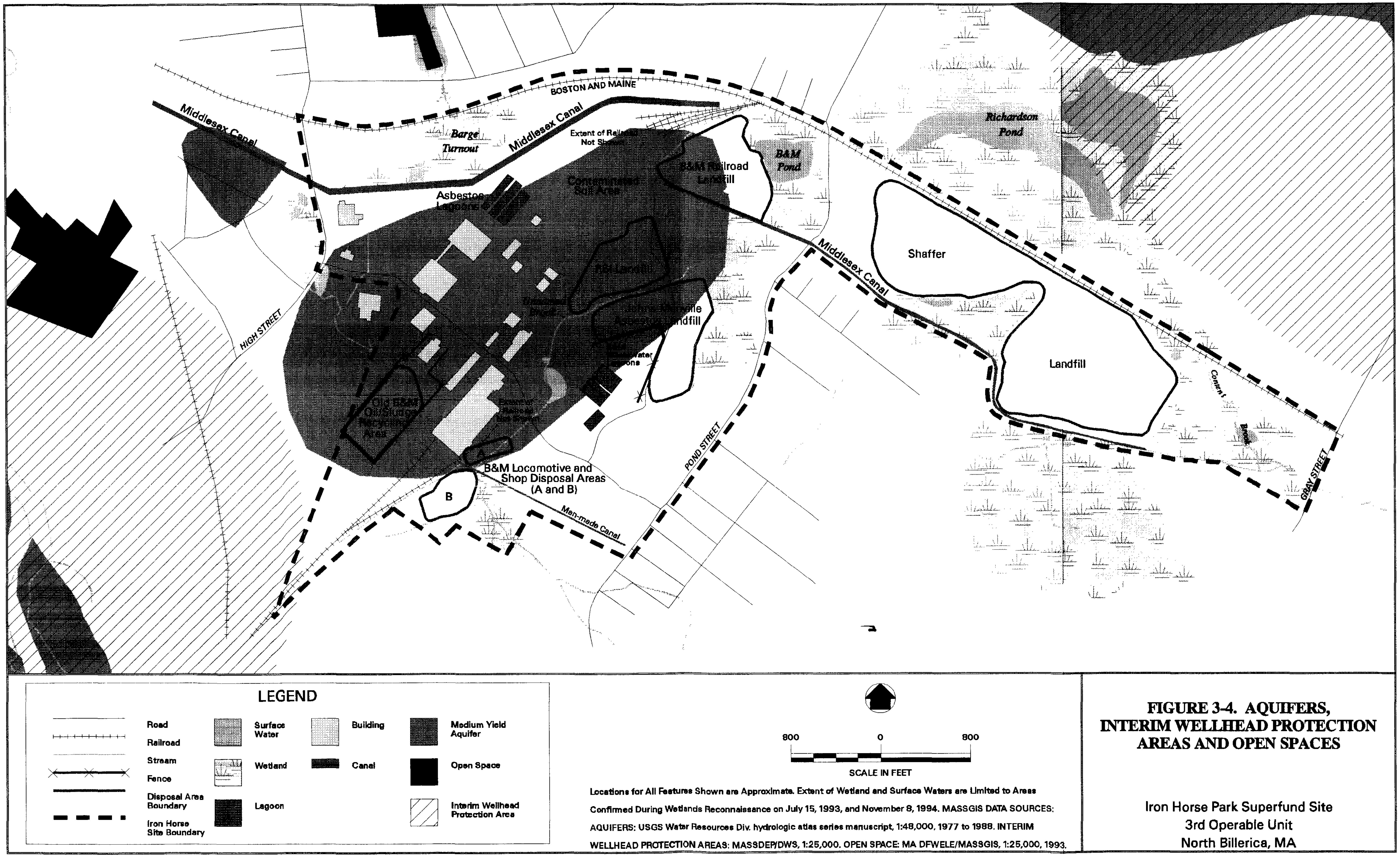


FIGURE 3-3. TOWN OF BILLERICA ZONING

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

5010/TK



Locations for All Features Shown are Approximate. Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993, and November 8, 1994. MASSGIS DATA SOURCES: AQUIFERS: USGS Water Resources Div. hydrologic atlas series manuscript, 1:48,000, 1977 to 1988. INTERIM WELLHEAD PROTECTION AREAS: MASSDEP/DWS, 1:25,000. OPEN SPACE: MA DFWELE/MASSGIS, 1:25,000, 1993.

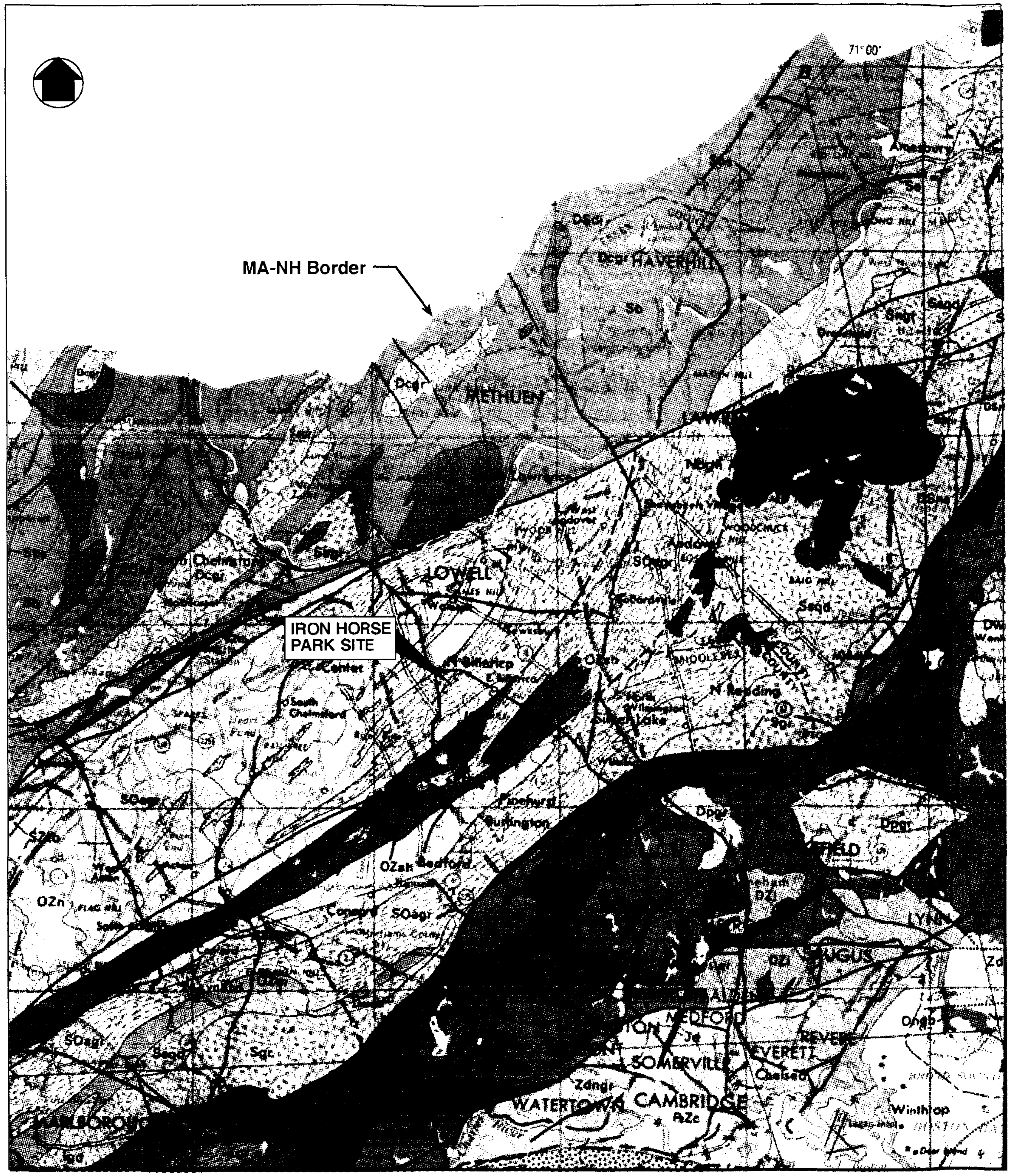
FIGURE 3-4. AQUIFERS, INTERIM WELLHEAD PROTECTION AREAS AND OPEN SPACES

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

massgis.aml July 1996

Original includes color coding.

Metcalf & Eddy



SOURCE: Zen et al., 1983

EXPLANATION OF MAP UNITS

NASHOBA ZONE INTRUSIVE ROCKS (SILURIAN AND OLDER)

- Sgr — Orange-Pink, medium to coarse-grained biotite granite to granodiorite (Silurian) - Locally porphyritic
- SSqd — **Sharpners Pond Diorite.** Non-foliated, medium grained biotite-hornblende tonalite and diorite.
- SSaqd — **Straw Hollow Diorite and Assabet Quartz** Diorite undifferentiated (Silurian). Gray, medium-grained biotite hornblende and quartz diorite.
- SOagr — **Andover Granite** (Silurian or Ordivician). Gray, medium to coarse-grained, foliated muscovite-biotite granite.

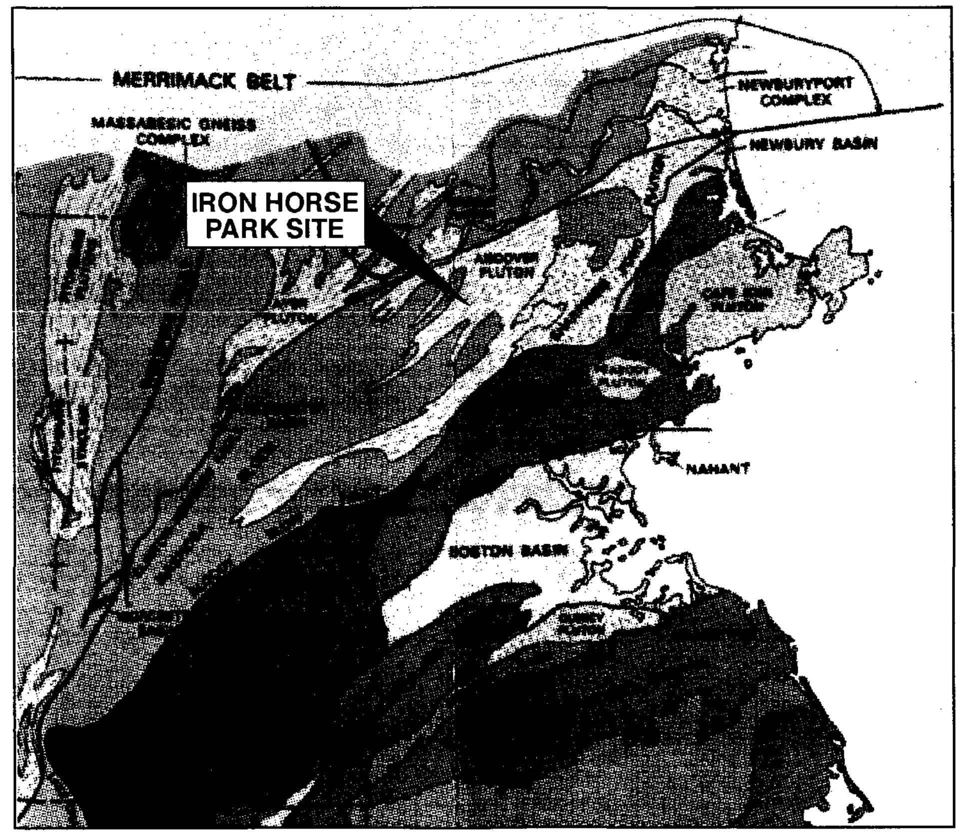
EXPLANATION

- Geologic Contact. Dashed where located approximately.
- Fault for which sense of movement is unknown or undifferentiated. Dashed where located approximately.

NASHOBA ZONE SEDIMENTARY AND VOLCANIC ROCKS (AND METAMORPHIC EQUIVALENTS)

- SZtb — **Tadmuck Brook Schist** (Silurian?, Ordivician, or Proterozoic.) Andalusite phyllite and sillimanite schist.
- Ozn — **Nashoba Formation.** Silliminite schist and gneiss, amphibolite, biotite gneiss and marble.
- **Boxford Member of Nasoba Formation.** Thin bedded to massive amphibolite, minor biotite gneiss.
- **Fish Brook Gneiss.** Light gray, biotite-plagioclase quartz gneiss.
- Ozsh — **Shawsheen Gneiss.** Silliminite gneiss; minor amphibolite
- Ozm — **Marlboro Formation.** Thinly layered amphibolite, biotite schist and gneiss.

TECTONIC MAP OF NE MASSACHUSETTS



SOURCE: Zen et al., 1983

20,000 0 20,000

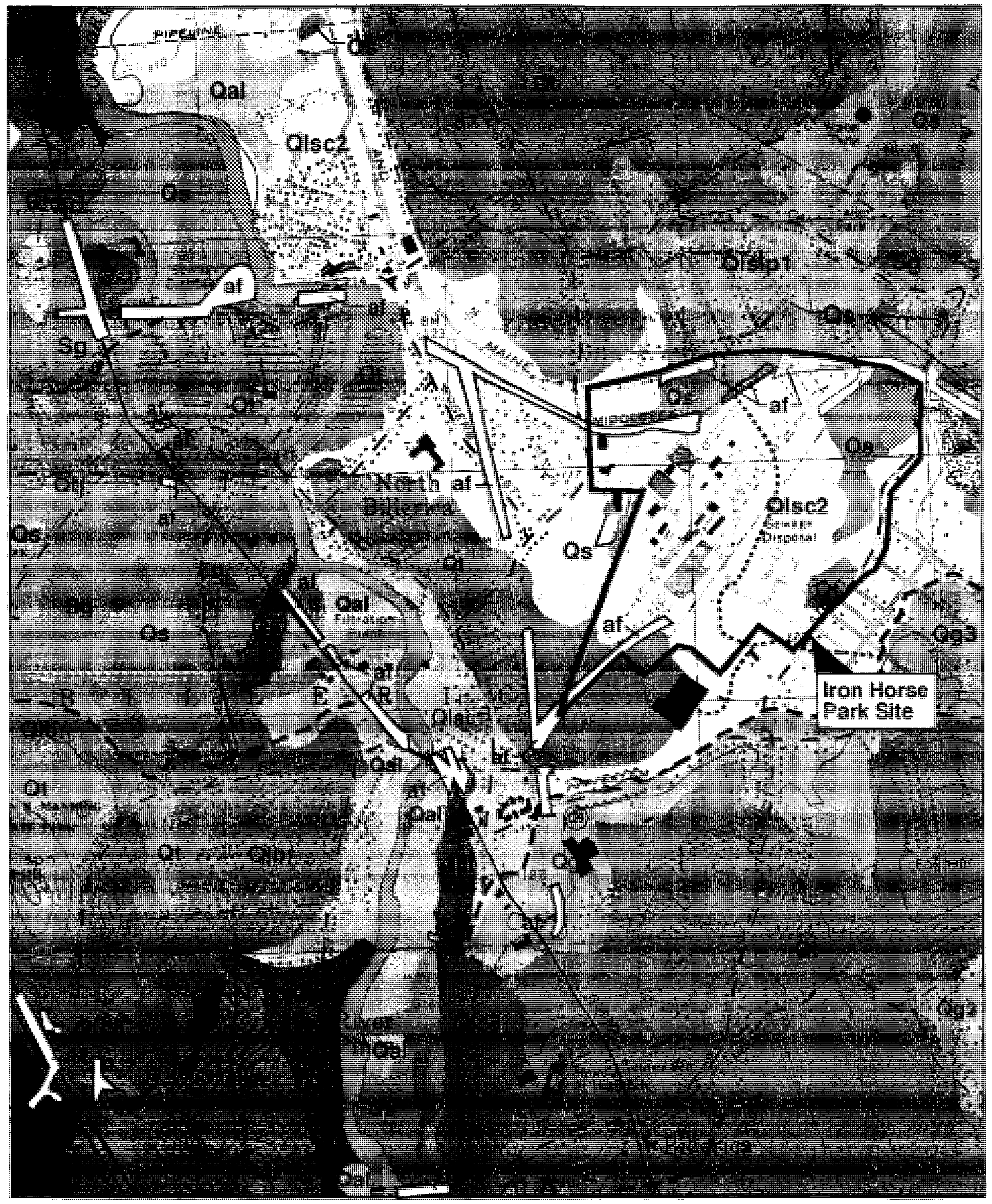
SCALE IN FEET

FIGURE 3-5. REGIONAL BEDROCK GEOLOGIC MAP

Iron Horse Superfund Site
3rd Operable Unit
North Billerica, MA

Original includes color coding.

5053jp



SOURCE: Holland (1980)
Billerica Quad, USGS (1979)

200 0 200
SCALE IN FEET

LEGEND

RECENT DEPOSITS

- Qal — RECENT ALLUVIUM - Fine sand & silt with some gravel and organic debris. Found chiefly in floodplains of modern streams.
- Qs — SWAMP DEPOSIT - Muck, peat, minor amounts of sand.
- STREAM TERRACE DEPOSITS - Primarily sand with minor amounts of pebble gravel. Formed mainly in late-glacial and early post-glacial time.

GLACIAL LAKE CONCORD DEPOSITS

- DEPOSITS ALONG THE CONCORD RIVER - Predominantly medium to coarse sand and pebble gravel. Some deposits contain moderate amounts of silt and silty sand. Coarsest materials are to be found in the proximal parts of each map unit, finest materials in the distal parts. Thickness of deposits likely averages about 40 feet. Subscripts give relative ages of map units.

GLACIAL LAKE SHAWSHEEN DEPOSITS

- DEPOSITS ALONG RIVER MEADOW BROOK - Generally fine to medium sand and pebble gravel with some cobble and boulder gravel in the highest horizons of the proximal aprts of the deposits.
- Qlsc2, Qlsc1 — DEPOSITS ALONG THE CONCORD RIVER - Composed largely of coarse pebbly sand and pebble gravel: Map unit Q1sc2 composed almost exclusively of medium sand.
- Qlsp1 — DEPOSITS OF THE LONG POND AREA - Largely ice-contact, fluvial and shallow lacustrine sediments composed chiefly of pebbly sand.

OTHER GLACIAL LAKE DEPOSITS

- DEPOSITS OF THE BRIDGE STREET AREA - Chiefly medium to coarse sand, with relatively well sorted pebble gravel at the highest horizons of the deposit. Probable outlet was the gap west of the railroad yard in North Billerica. This may possibly be the oldest deposit of Glacial Lake Shawsheen in the Billerica Quadrangle. Thickness likely less than 30 feet.
- Qg3 — Primarily coarse sand and pebble gravel. Textures generally coarser than glaciolacustrine deposits. Deposited almost entirely in contact with ice. Thicknesses variable, ranging from less than 10 feet to perhaps 30 feet. Subscript gives relative order of formation.
- UNCORRELATED GLACIAL STREAM DEPOSITS
- Sg — SAND AND GRAVEL, UNDIFFERENTIATED - Sand and gravel deposits of uncertain origin. May include kettle-fillings, some terrace deposits, and minor lake bottom deposits.
- Qt — TILL, UNDIVIDED - Textures and composition quite variable. Generally poorly sorted, containing angular clasts of up to large boulder size. Relatively less permeable than other mapped glacial deposits. Deposited directly by active ice.
- Surface Water (River, Stream or Pond)
- Contact. Dashed where located approximately.
- Inferred ice margin.
- Glacial tool mark. Includes chattermarks, striations and grooves. Observation is at tip of arrow.
- Axis of drumlin elongation.
- Channel.
- Spillway.
- s,p,c,b — Sand or gravel pit. Letter symbols indicate textures in order of decreasing abundance, s. sand; p. pebble; c, cobble; b. boulder.
- Bedrock outcrop; Ruled lines indicate approximate areas where drift is less than 10 feet thick.
- Artificial fill. (af)
- e — Letter symblols indicate examples of morphological features; k, kame; kd, kame delta; od, outwash delta; vt, valley train; d, drumlin; f, fal; e, esker.

SOURCE: Holland (1980) and Billerica Quad, USGS (1979)

4493df/Z1hw

Original includes color coding.

FIGURE 3-6. REGIONAL SURFICIAL GEOLOGIC MAP

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

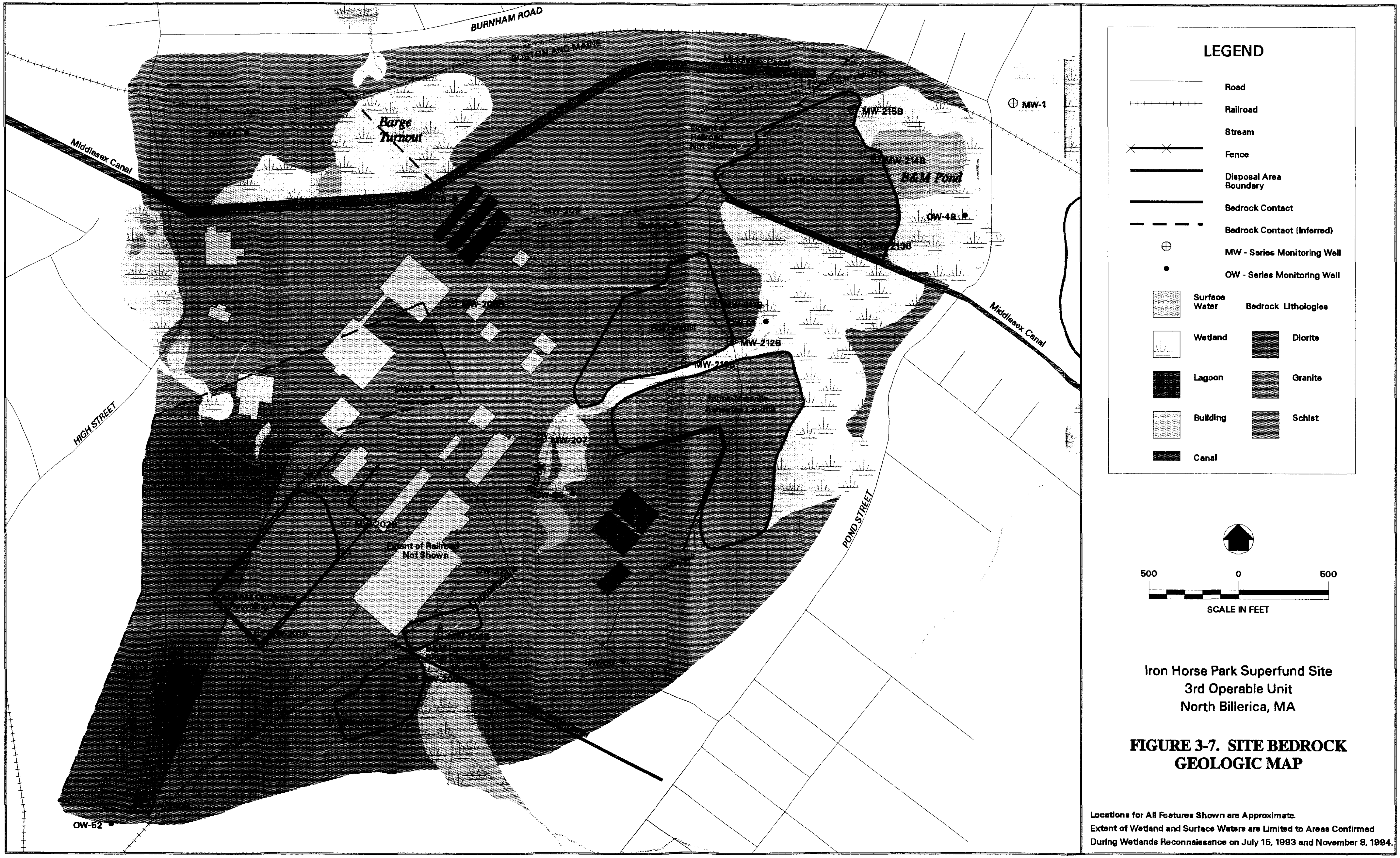
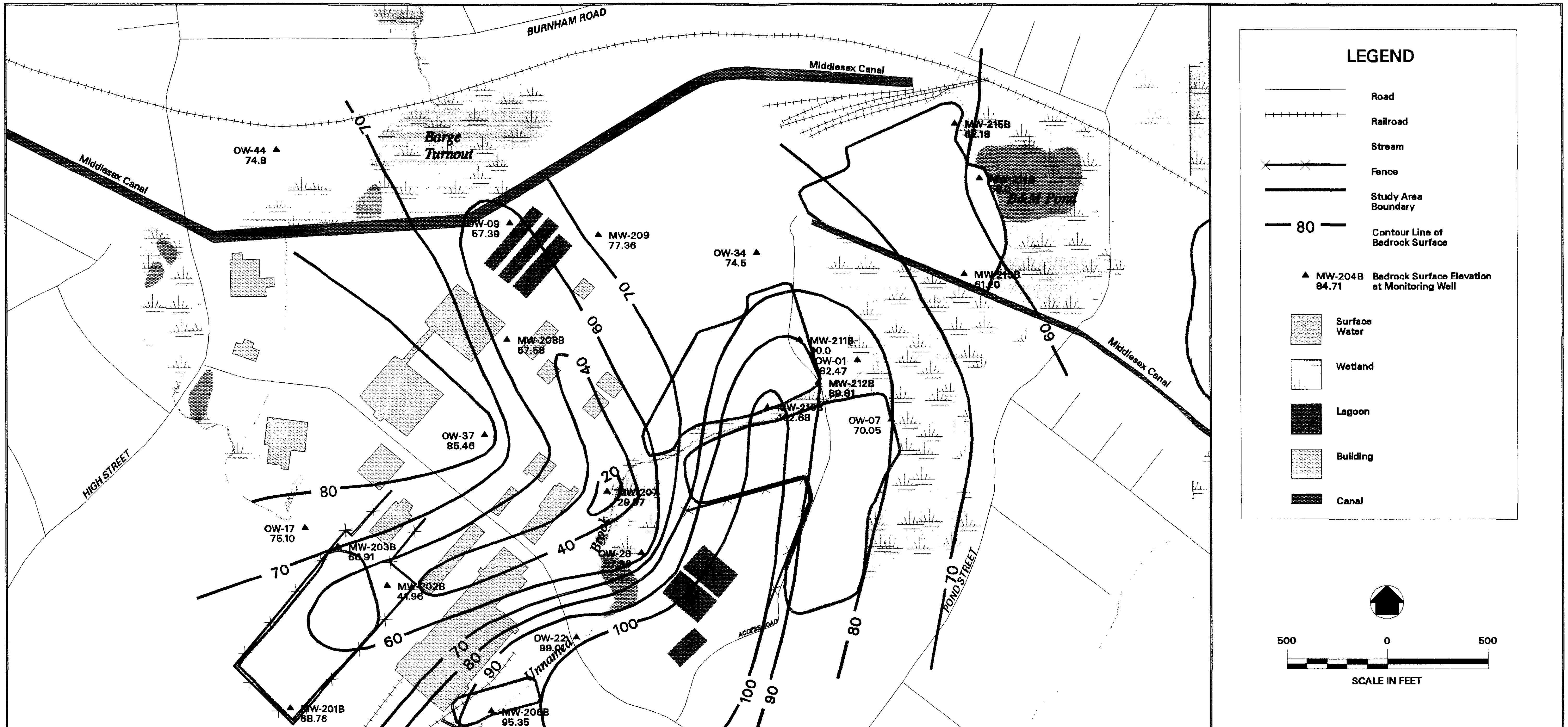


FIGURE 3-7. SITE BEDROCK GEOLOGIC MAP

rocktypes.aml July 1996

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

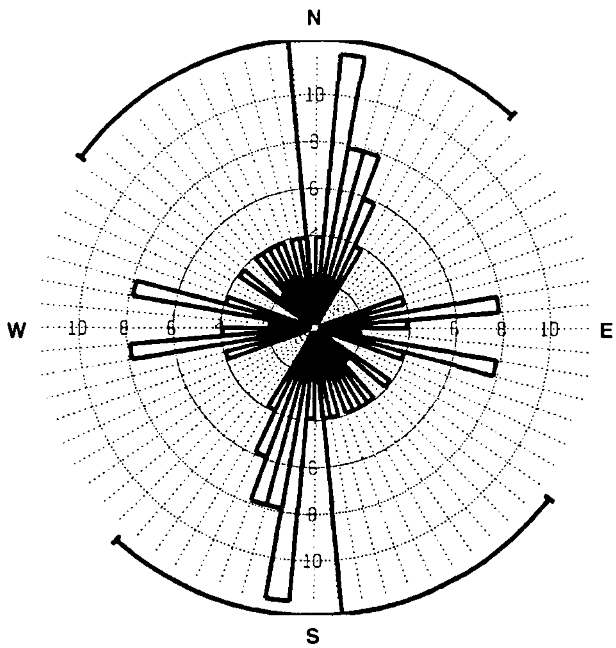
FIGURE 3-8. BEDROCK SURFACE TOPOGRAPHY

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

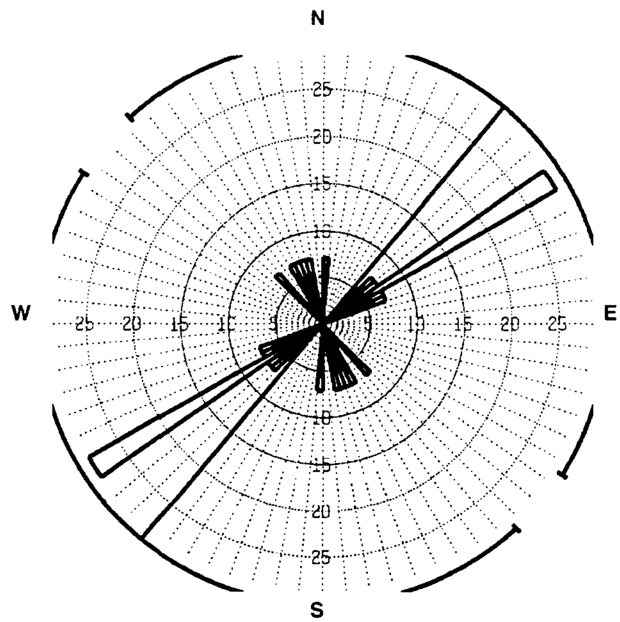
bdrckcont.aml July 1996

Original includes color coding.

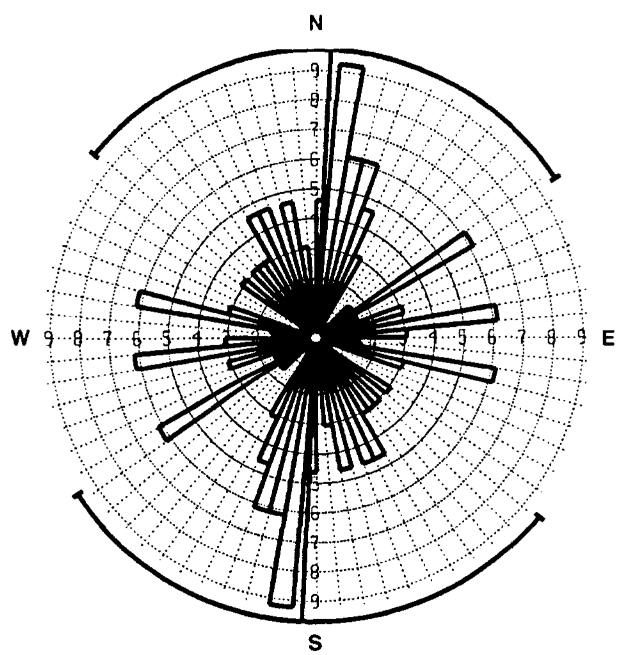
Metcalf & Eddy



ROSE DIAGRAM OF STRIKE
GRANITE OUTCROPS - POND ST. & MOOSEWOOD ST.
IRON HORSE PARK - 3rd OPERABLE UNIT

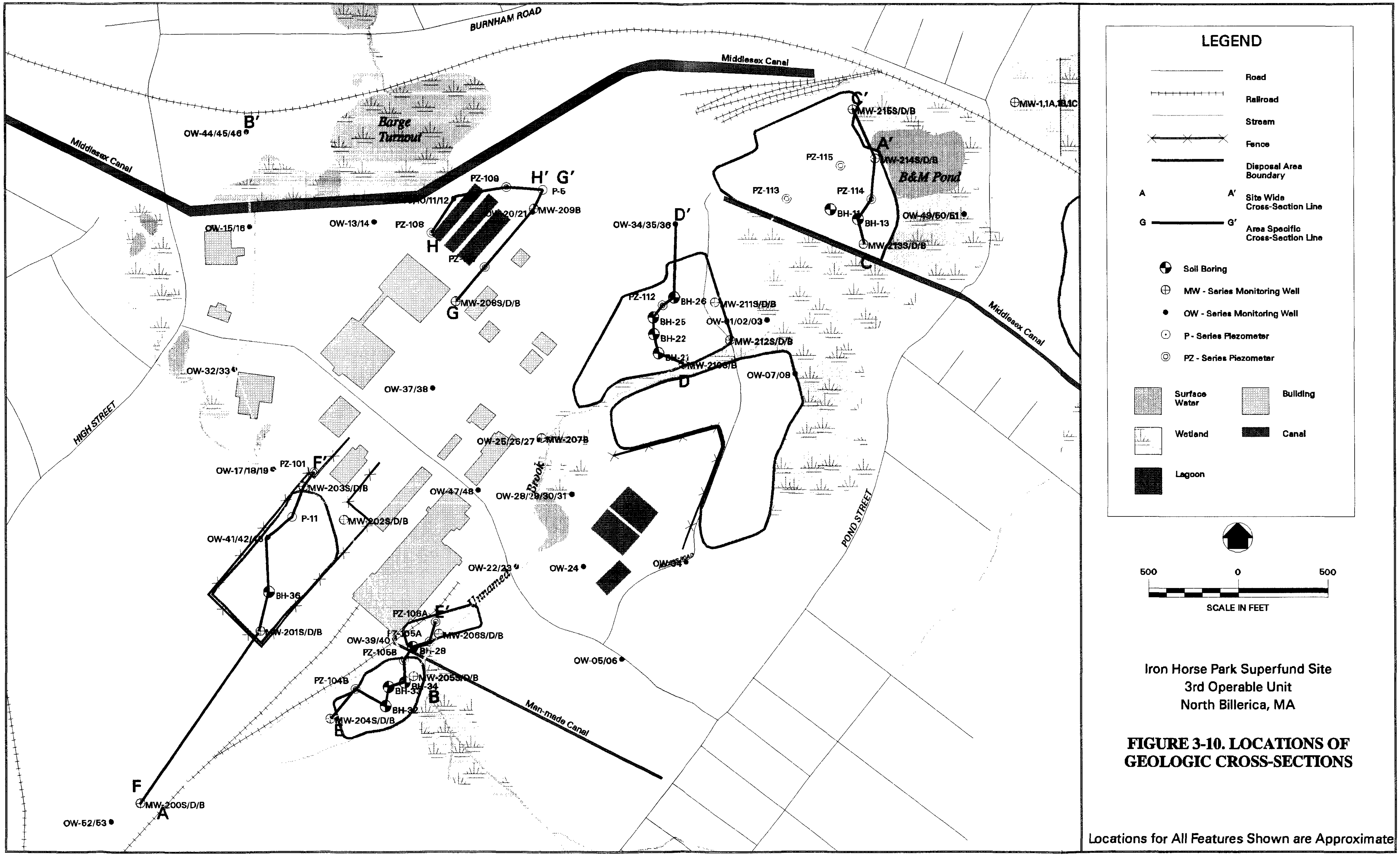


ROSE DIAGRAM OF STRIKE-JOINTS
MIGMITITE OUTCROPS - HIGH STREET VICINITY
IRON HORSE PARK - 3rd OPERABLE UNIT



ROSE DIAGRAM OF STRIKE
ALL OUTCROPS - GRANITE AND MIGMITITE
IRON HORSE PARK - 3rd OPERABLE UNIT

FIGURE 3-9. ROSE DIAGRAMS OF BEDROCK JOINT ORIENTATIONS



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

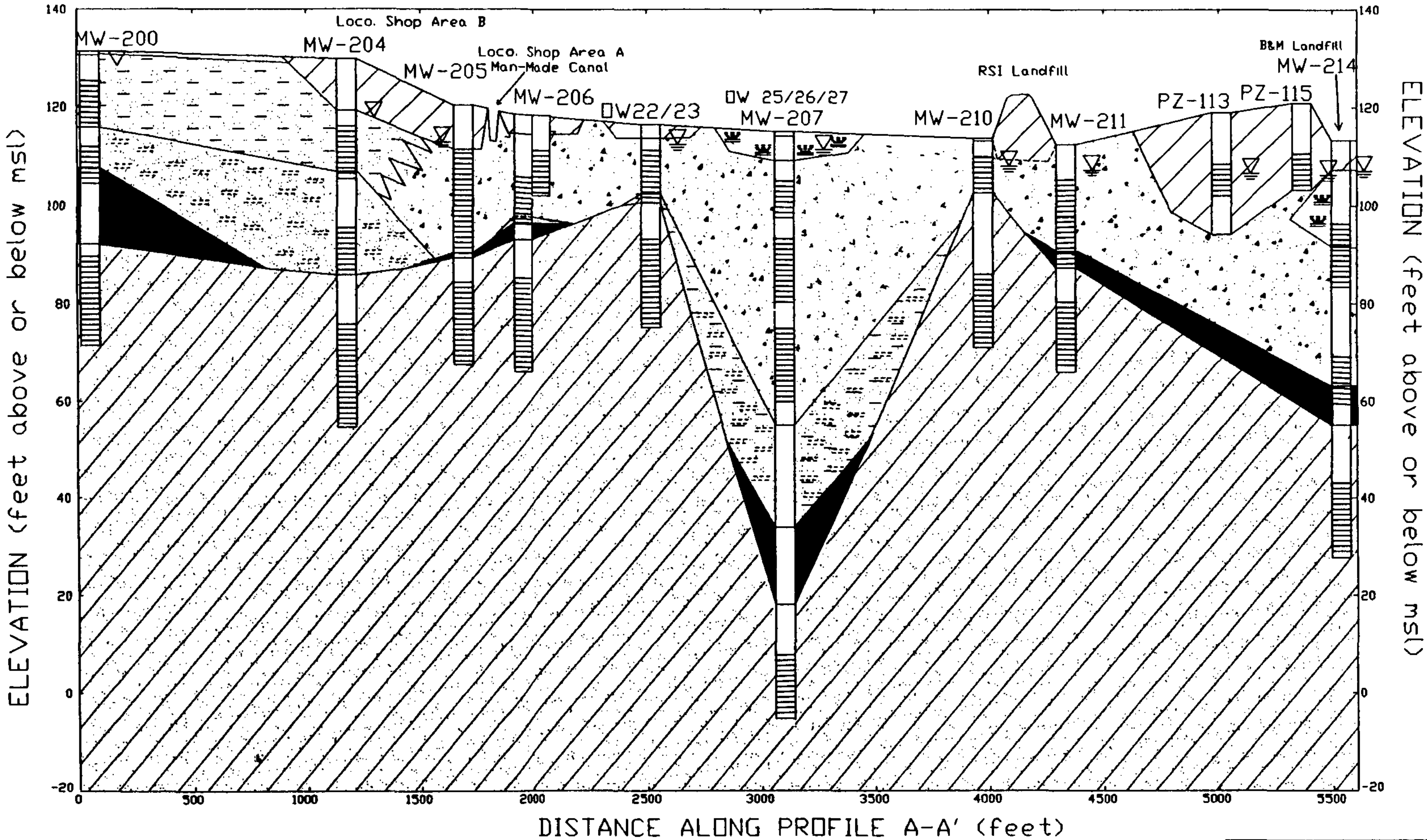
FIGURE 3-10. LOCATIONS OF GEOLOGIC CROSS-SECTIONS

Locations for All Features Shown are Approximate

fig3-c.aml July 1996

Original includes color coding.

Metcalf & Eddy



Notes: -Soil boring lithologies up to a maximum of 200 feet on either side of the sections were projected perpendicularly into the section line.
-The surface topography between each test boring used for the creation of the cross-section was projected perpendicularly onto the section line
- OV and P series soil borings are from the Phase IA RI report (CDM, 1987)
BH series soil borings are from the Hydrogeologic Assessment Report (M&E, 1994a)

Static Water Level (4/12/95)

Inferred Contact

Formational Contact

Screened Interval

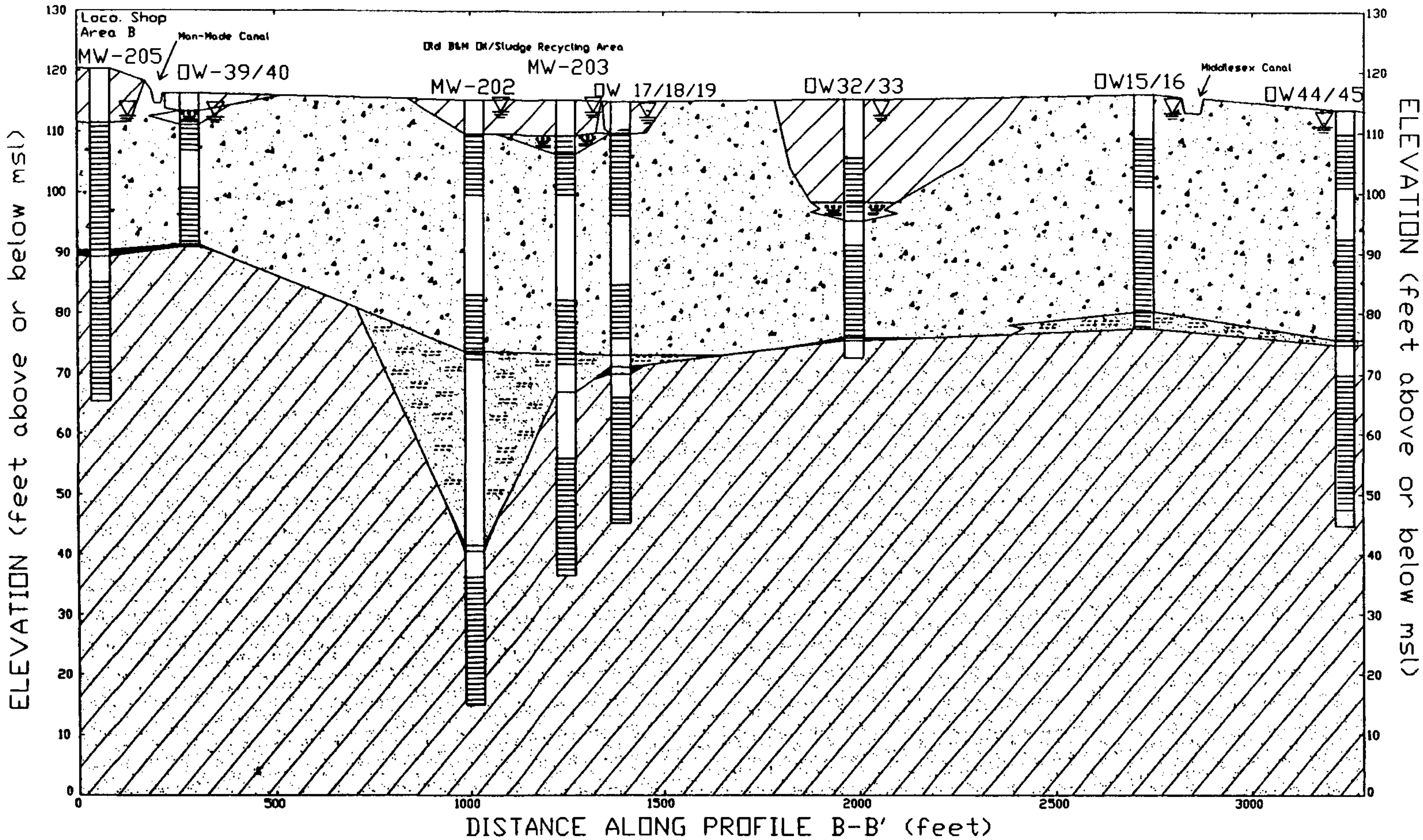
LEGEND

- FILL
- PEAT
- GLACIAL OUTWASH
- GLACIAL TILL (ABLATION)
- GLACIAL TILL (BASAL)
- GLACIAL TILL (UNDIFFERENTIATED)
- WEATHERED BEDROCK
- BEDROCK - GRANITE

FIGURE 3-11. GEOLOGIC CROSS-SECTION A-A', SITE-WIDE

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

M&E



Notes: -Soil boring lithologies up to a maximum of 200 feet on either side of the sections were projected perpendicularly into the section line.
-The surface topography between each test boring used for the creation of the cross-section was projected perpendicularly onto the section line
- OW and P series soil borings are from the Phase 1A RI report (CDM, 1987) BH series soil borings are from the Hydrogeologic Assessment Report (M&E, 1994a)

Static Water Level (4/12/95)

Inferred Contact

Formational Contact

Screened Interval

LEGEND

FILL

PEAT

GLACIAL OUTWASH

GLACIAL TILL (ABLATION)

GLACIAL TILL (BASAL)

GLACIAL TILL (UNDIFFERENTIATED)

WEATHERED BEDROCK

BEDROCK - GRANITE

FIGURE 3-12. GEOLOGIC CROSS-SECTION B-B', SITE-WIDE

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

M&E

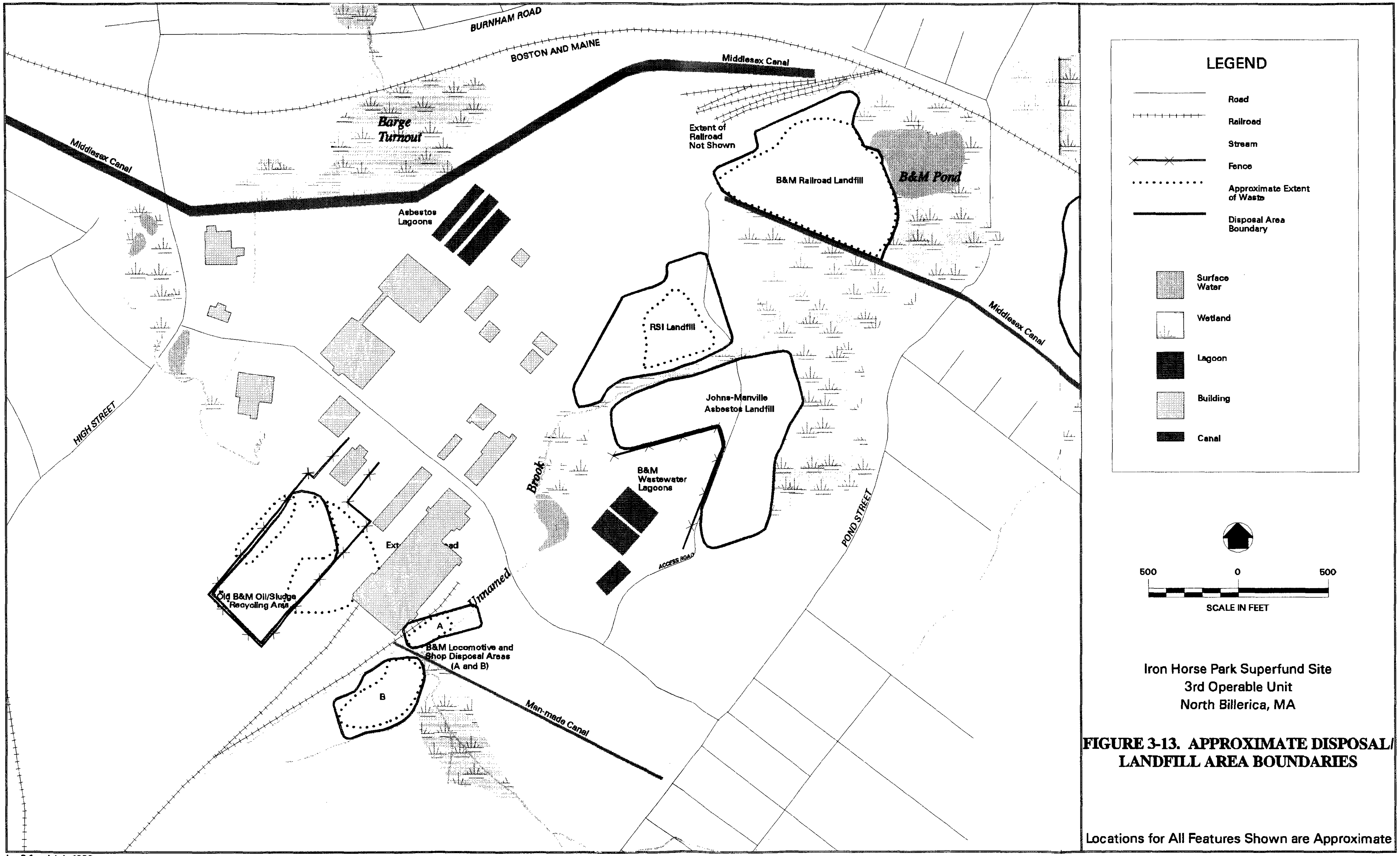
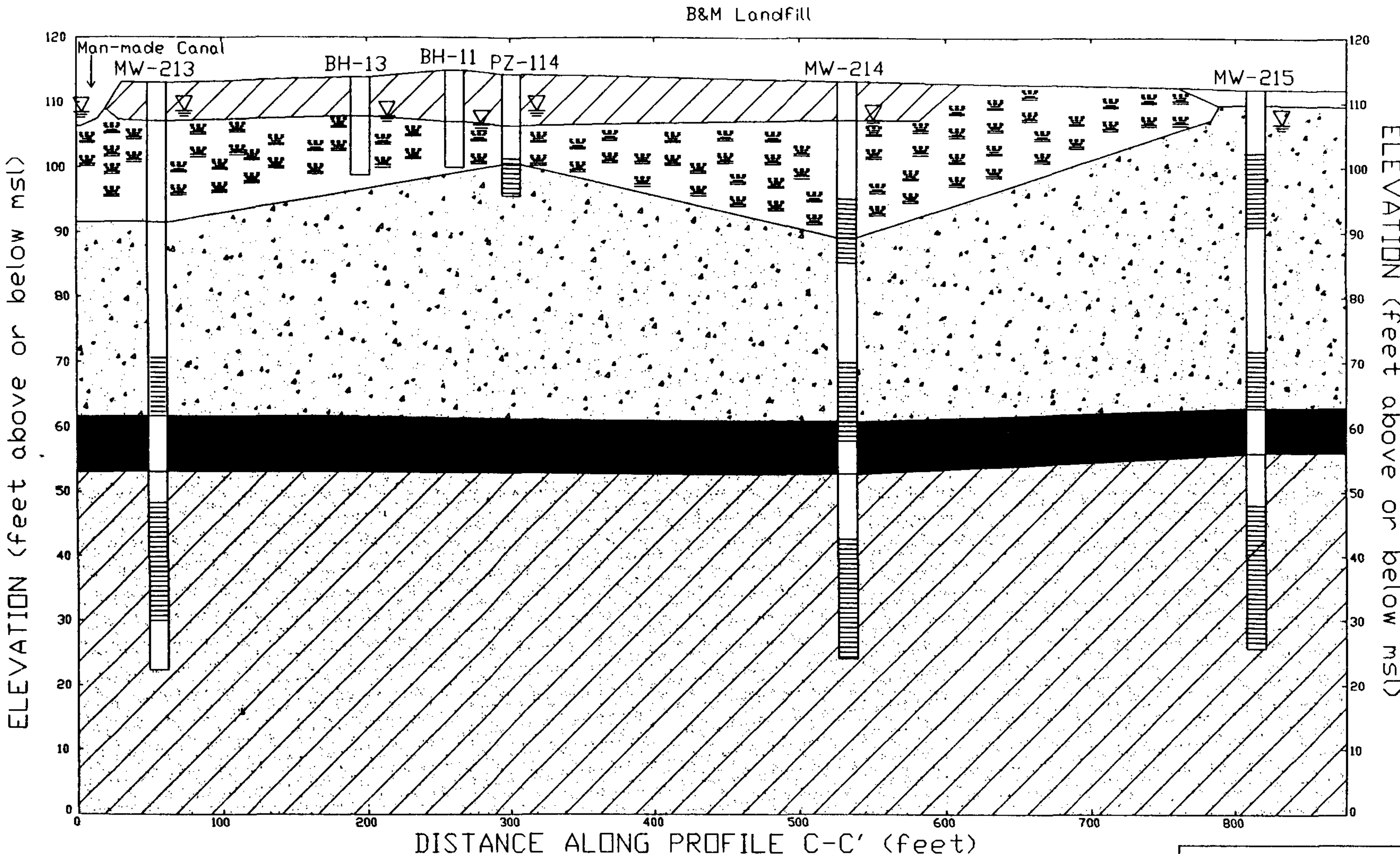


FIGURE 3-13. APPROXIMATE DISPOSAL/ LANDFILL AREA BOUNDARIES

hgr3-1.aml July 1998

Original includes color coding.

Metcalf & Eddy



Notes: -Soil boring lithologies up to a maximum of 200 feet on either side of the sections were projected perpendicularly into the section line.
-The surface topography between each test boring used for the creation of the cross-section was projected perpendicularly onto the section line
- OW and P series soil borings are from the Phase 1A RI report (CDM, 1987) BH series soil borings are from the Hydrogeologic Assessment Report (M&E, 1994a)

Static Water Level (4/12/95)

- - - - Inferred Contact

Formational Contact

Screened Interval

LEGEND

FILL

QUATERNARY DEPOSITES

PEAT

GLACIAL OUTWASH

GLACIAL TILL (ABLATION)

GLACIAL TILL (BASAL)

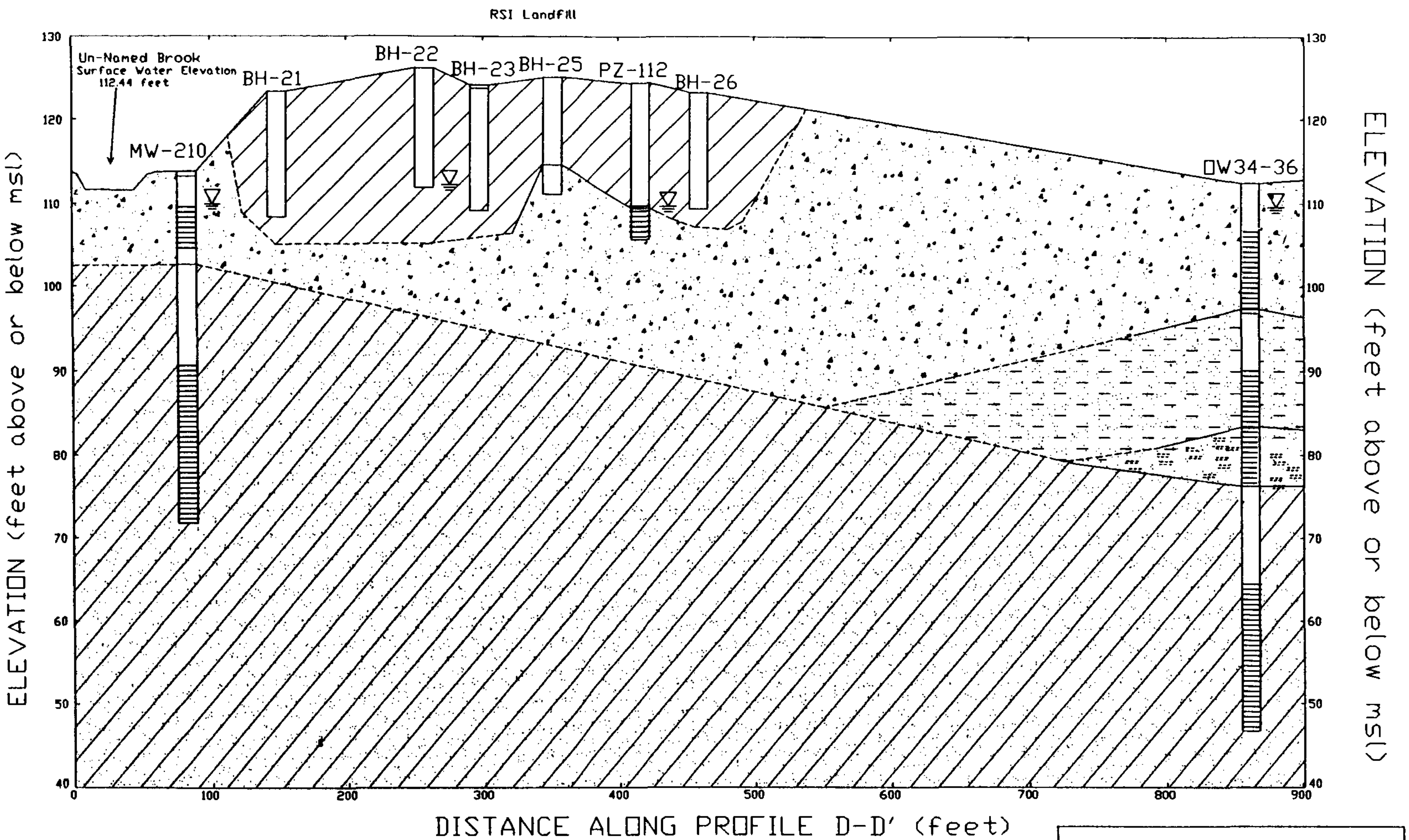
WEATHERED BEDROCK

BEDROCK - GRANITE

FIGURE 3-14. GEOLOGIC CROSS-SECTION C-C′, B&M RAILROAD LANDFILL

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

M&E



Notes: -Soil boring lithologies up to a maximum of 200 feet on either side of the sections were projected perpendicularly into the section line.
-The surface topography between each test boring used for the creation of the cross-section was projected perpendicularly onto the section line
- OW and P series soil borings are from the Phase 1A RI report (CDM, 1987) BH series soil borings are from the Hydrogeologic Assessment Report (M&E, 1994a)

Static Water Level (4/12/95)

Inferred Contact

Formational Contact

Screened Interval

LEGEND

FILL

PEAT

GLACIAL OUTWASH

GLACIAL TILL (ABLATION)

GLACIAL TILL (BASAL)

GLACIAL TILL (UNDIFFERENTIATED)

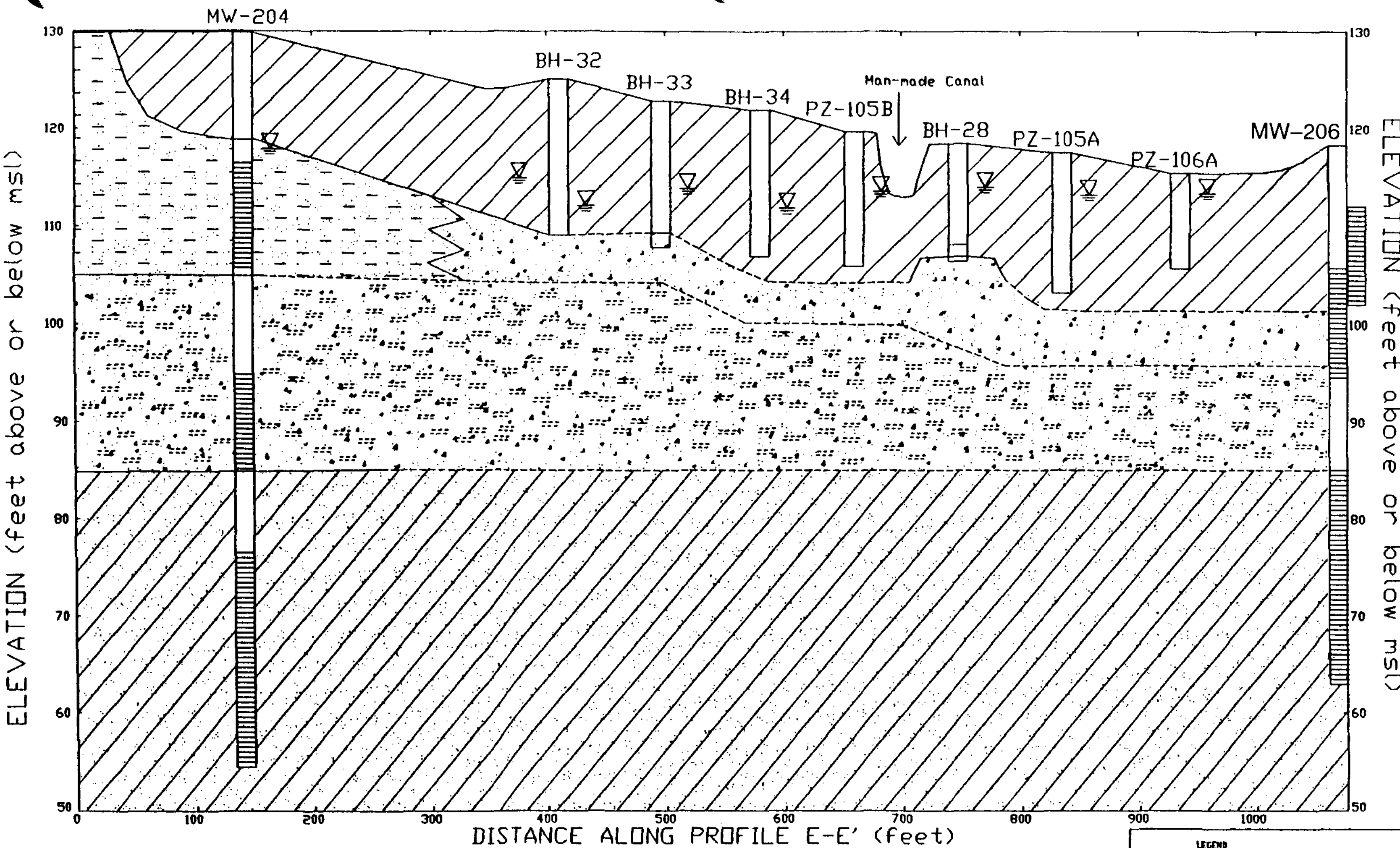
WEATHERED BEDROCK

BEDROCK - GRANITE

FIGURE 3-15. GEOLOGIC CROSS-SECTION D-D', RSI LANDFILL

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

M&E



Notes: -Soil boring lithologies up to a maximum of 200 feet on either side of the sections were projected perpendicularly into the section line.
-The surface topography between each test boring used for the creation of the cross-section was projected perpendicularly onto the section line
- DV and P series soil borings are from the Phase IA RI report (CDM, 1987) BH series soil borings are from the Hydrogeologic Assessment Report (M&E, 1994a)

Static Water Level (4/12/95)
Inferred Contact
Formational Contact
Screened Interval

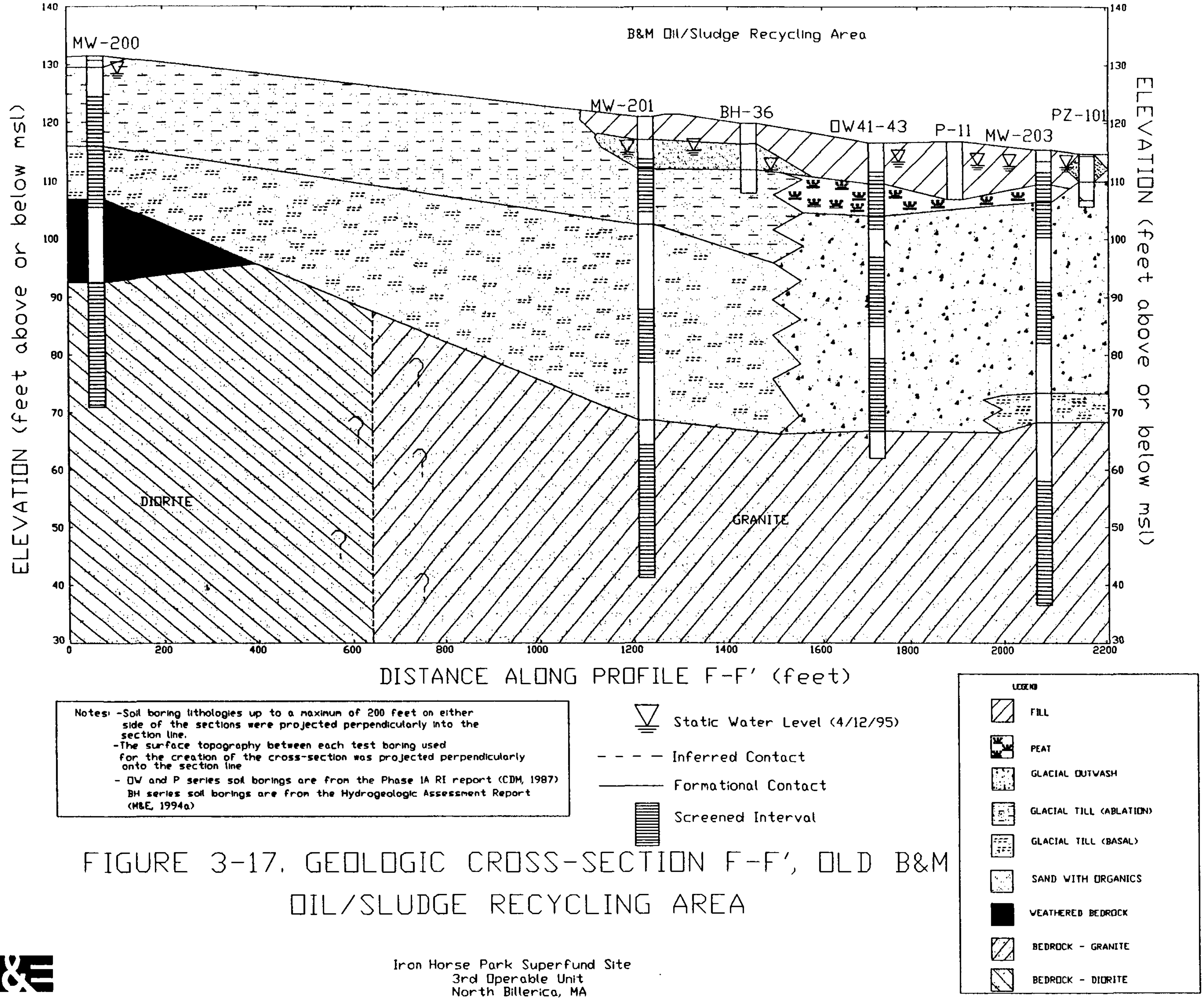
LEGEND

FILL
PEAT
GLACIAL OUTWASH
GLACIAL TILL (ABLATION)
GLACIAL TILL (BASAL)
GLACIAL TILL (UNDIFFERENTIATED)
WEATHERED BEDROCK
BEDROCK - GRANITE

FIGURE 3-16. GEOLOGIC CROSS-SECTION E-E', B&M LOCOMOTIVE SHOP DISPOSAL AREAS A AND B

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

M&E

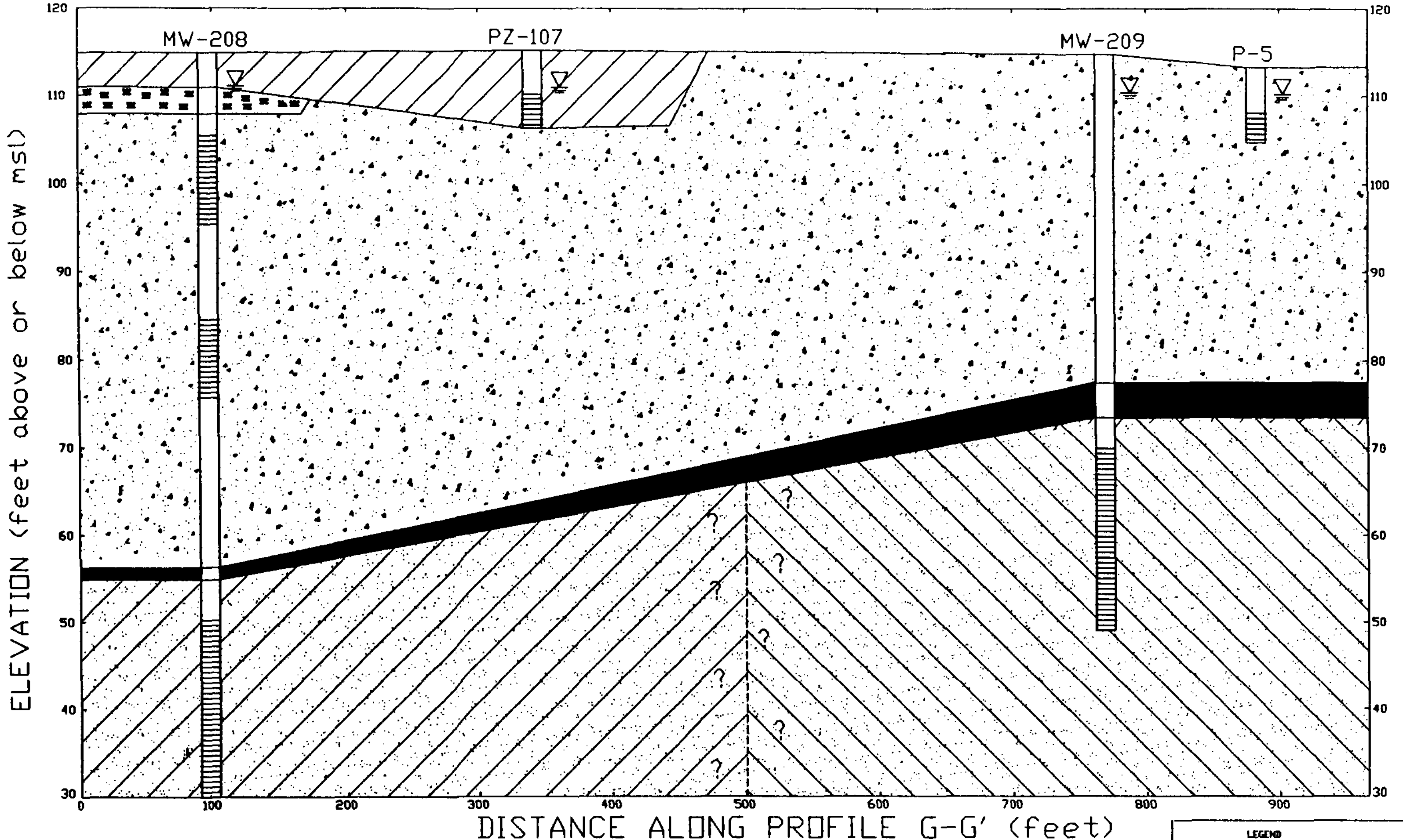


Notes: -Soil boring lithologies up to a maximum of 200 feet on either side of the sections were projected perpendicularly into the section line.
-The surface topography between each test boring used for the creation of the cross-section was projected perpendicularly onto the section line
- OW and P series soil borings are from the Phase IA RI report (CDM, 1987) BH series soil borings are from the Hydrogeologic Assessment Report (M&E, 1994a)

FIGURE 3-17. GEOLOGIC CROSS-SECTION F-F', OLD B&M OIL/SLUDGE RECYCLING AREA

M&E

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA



Notes: -Soil boring lithologies up to a maximum of 200 feet on either side of the sections were projected perpendicularly into the section line.
-The surface topography between each test boring used for the creation of the cross-section was projected perpendicularly onto the section line
- OW and P series soil borings are from the Phase IA RI report (CDM, 1987) BH series soil borings are from the Hydrogeologic Assessment Report (M&E, 1994a)

Static Water Level (4/12/95)

Inferred Contact

Formational Contact

Screened Interval

LEGEND

FILL

PEAT

GLACIAL OUTWASH

GLACIAL TILL (ABLATION)

GLACIAL TILL (BASAL)

GLACIAL TILL (UNDIFFERENTIATED)

WEATHERED BEDROCK

BEDROCK- GRANITE

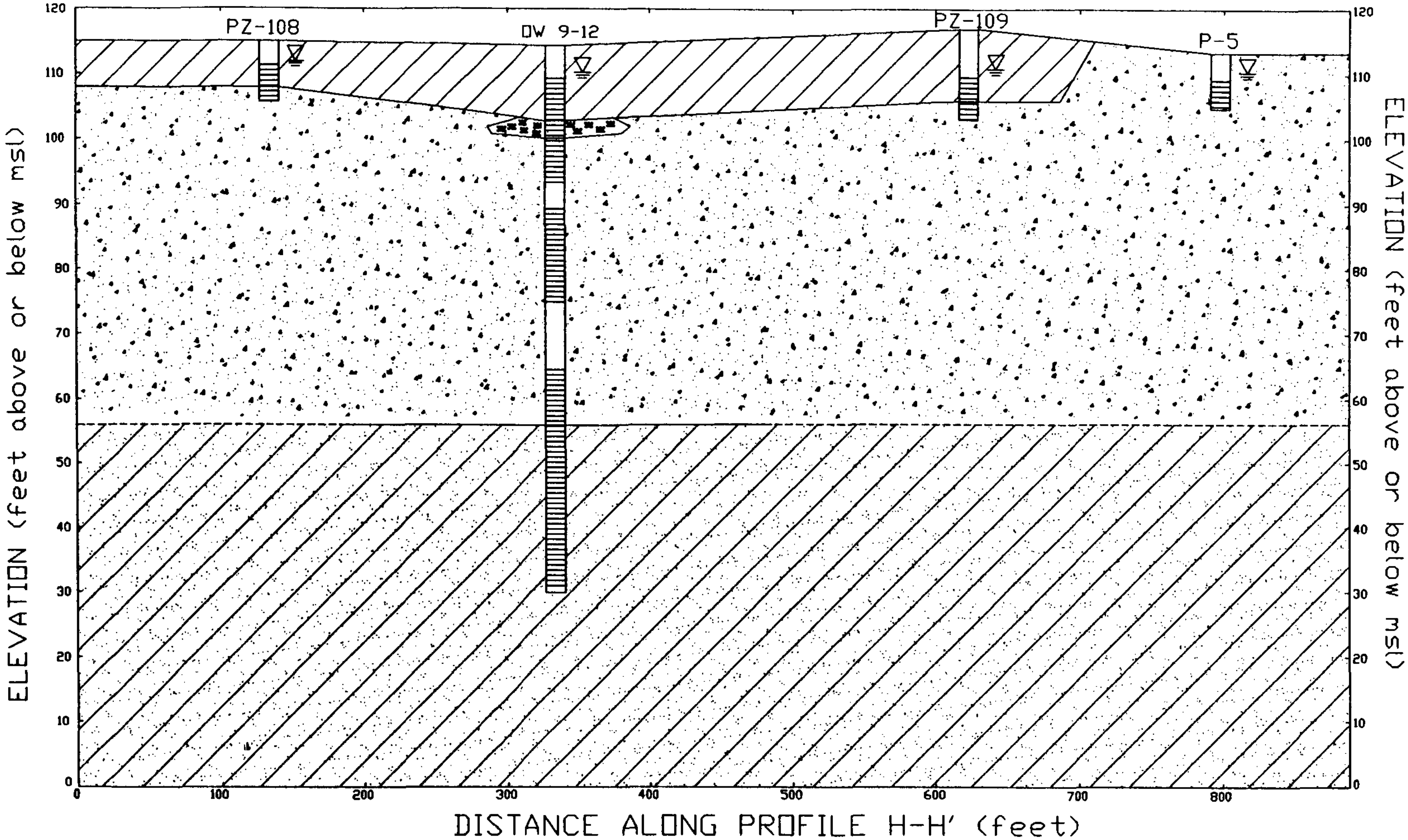
BEDROCK- SCHIST

FIGURE 3-18. GEOLOGIC CROSS-SECTION G-G',

ASBESTOS LAGOONS

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

M&E



Notes: -Soil boring lithologies up to a maximum of 200 feet on either side of the sections were projected perpendicularly into the section line.
-The surface topography between each test boring used for the creation of the cross-section was projected perpendicularly onto the section line
- OW and P series soil borings are from the Phase 1A RI report (CDM, 1987) BH series soil borings are from the Hydrogeologic Assessment Report (M&E, 1994a)

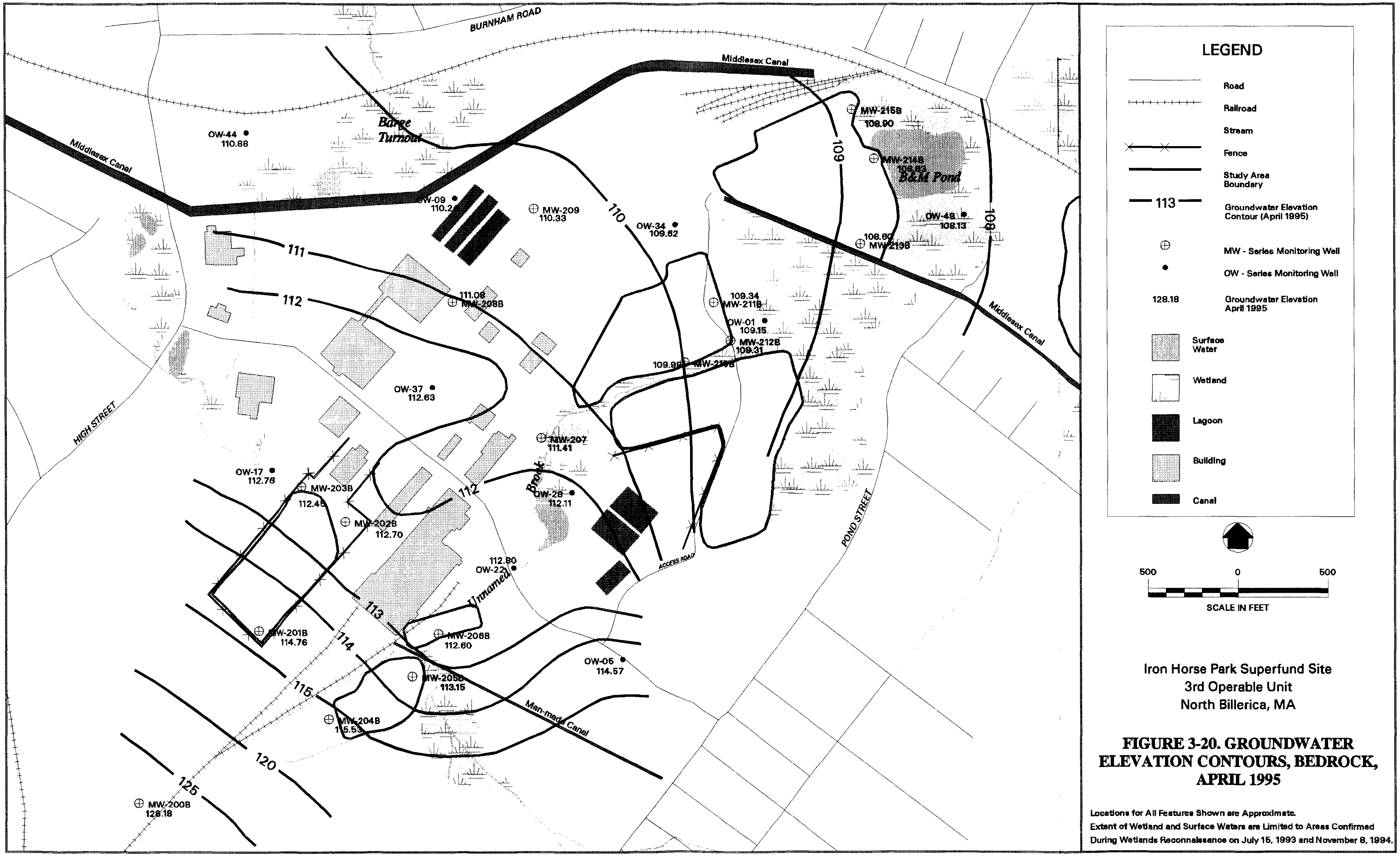
Static Water Level (4/12/95)
Inferred Contact
Formational Contact
Screened Interval

LEGEND
FILL
PEAT
GLACIAL OUTWASH
GLACIAL TILL (ABLATION)
GLACIAL TILL (BASAL)
GLACIAL TILL (UNDIFFERENTIATED)
WEATHERED BEDROCK
BEDROCK - GRANITE

FIGURE 3-19. GEOLOGIC CROSS-SECTION H-H'
ASBESTOS LAGOONS

M&E

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 3-20. GROUNDWATER ELEVATION CONTOURS, BEDROCK, APRIL 1995

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

fig3-l.aml July 1996

Original includes color coding.

Metcalf & Eddy

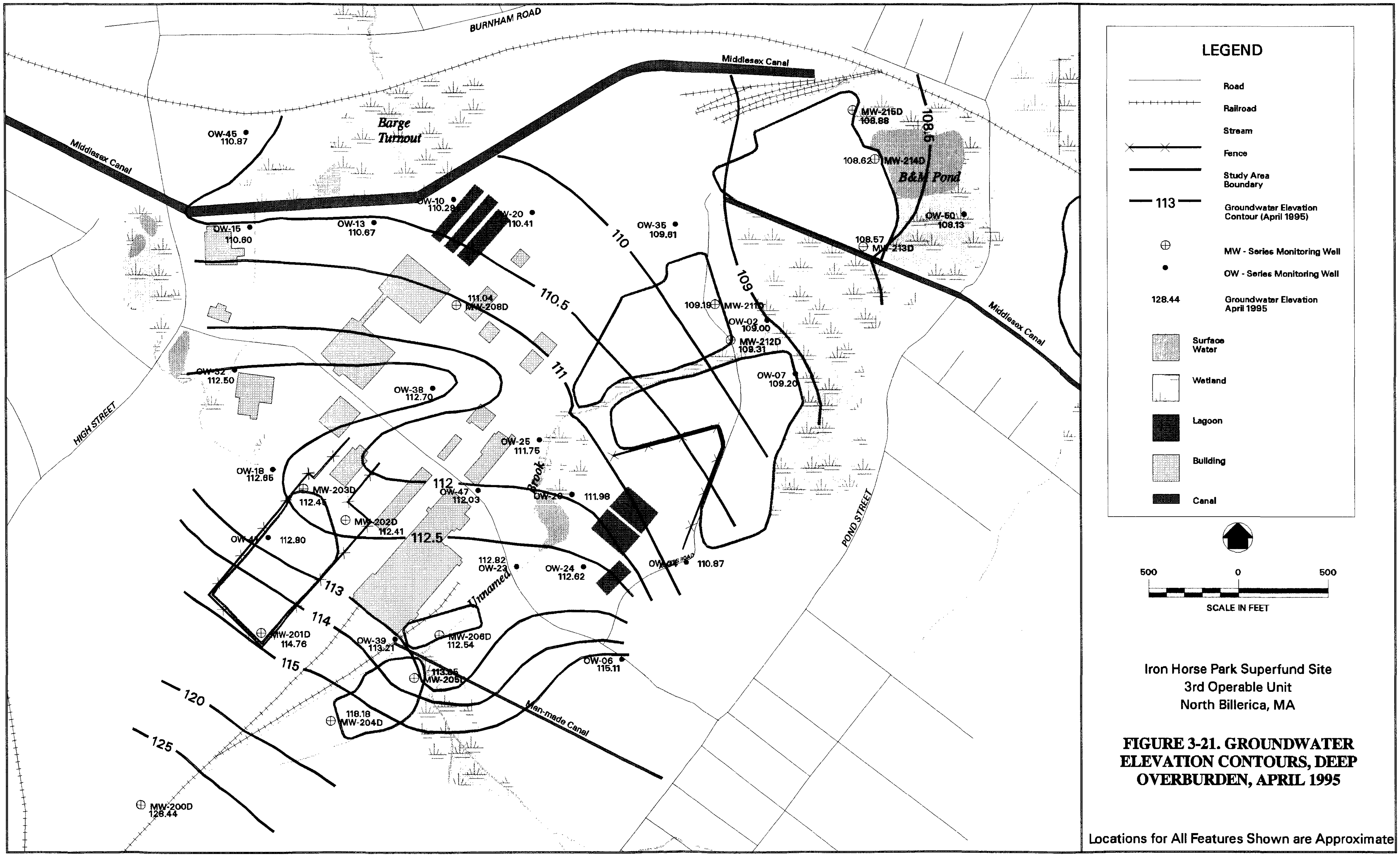


FIGURE 3-21. GROUNDWATER ELEVATION CONTOURS, DEEP OVERBURDEN, APRIL 1995

fig3-m.aml July 1996

Original includes color coding.

Metcalf & Eddy

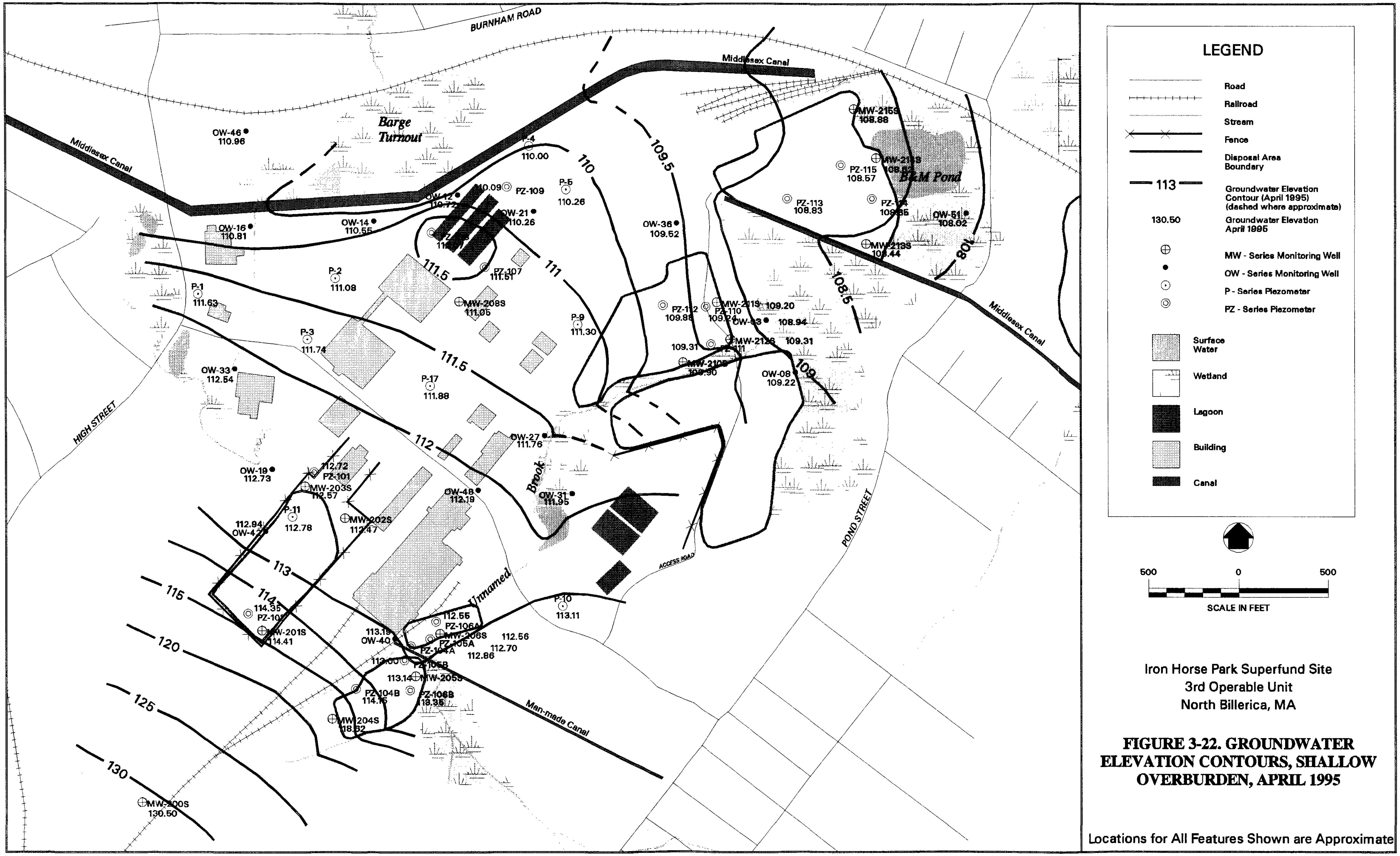
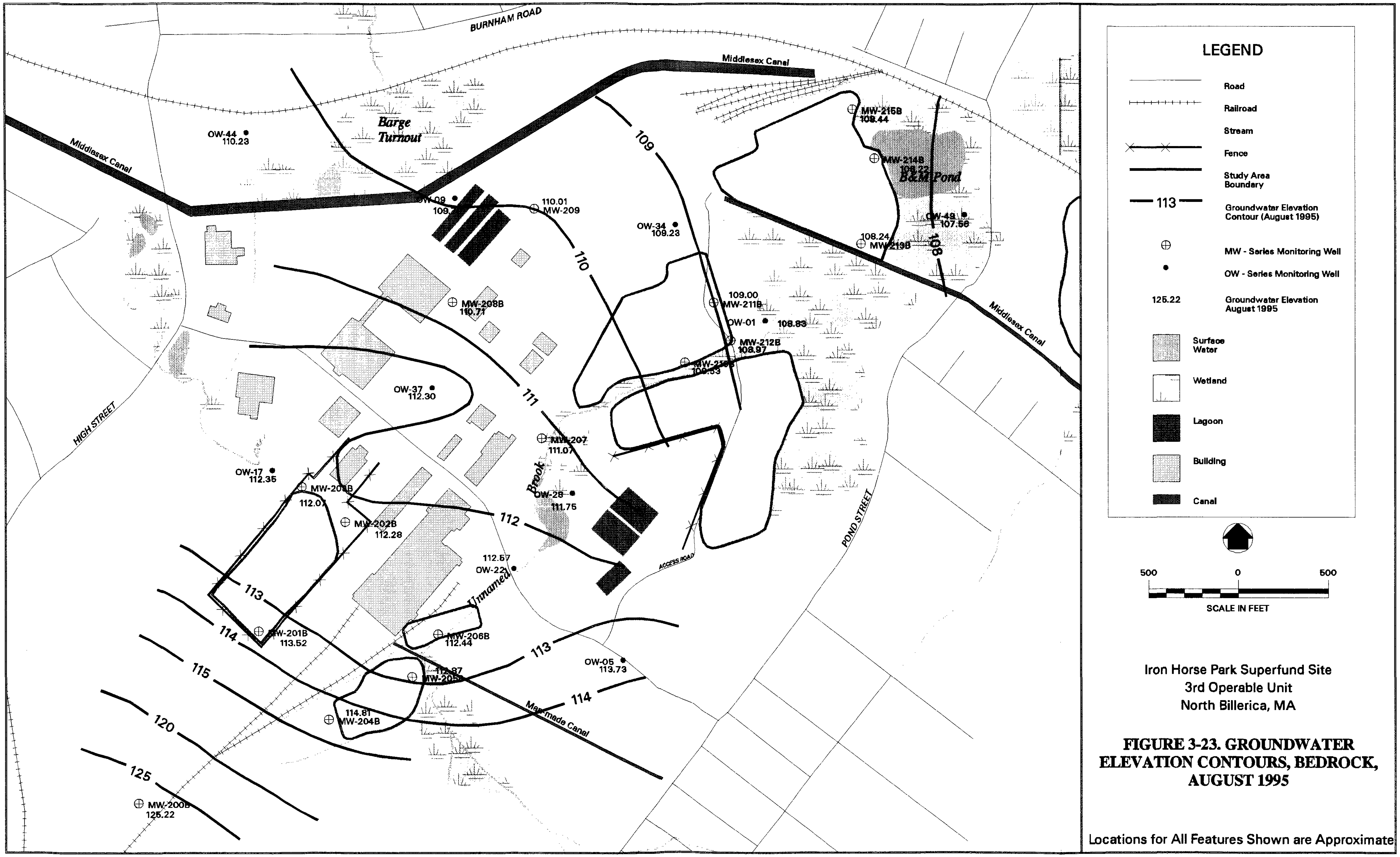


FIGURE 3-22. GROUNDWATER ELEVATION CONTOURS, SHALLOW OVERBURDEN, APRIL 1995

fig3-n.gra July 1996

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 3-23. GROUNDWATER ELEVATION CONTOURS, BEDROCK, AUGUST 1995

Locations for All Features Shown are Approximate

fig3-0.aml July 1996

Original includes color coding.

Metcalf & Eddy

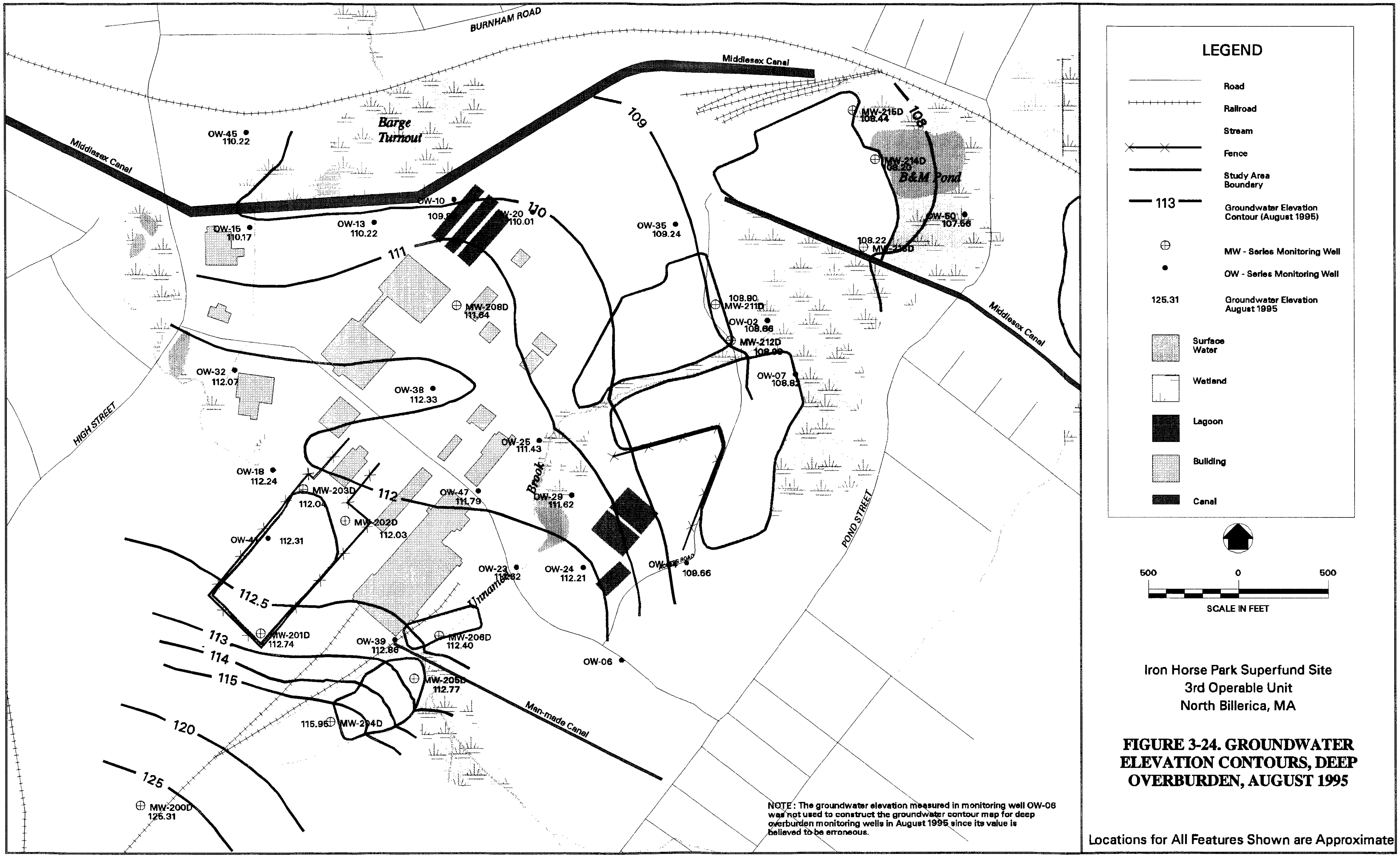


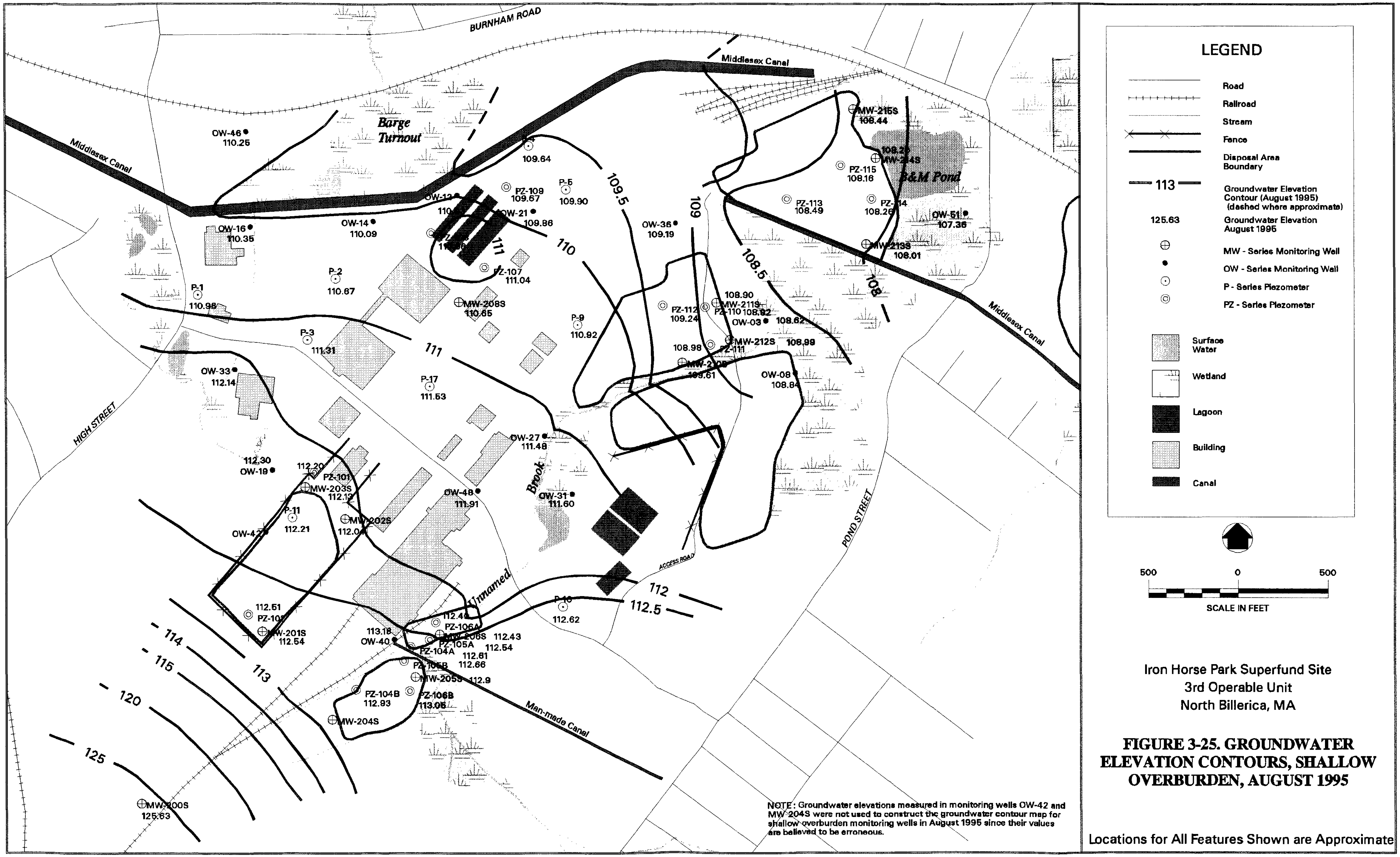
FIGURE 3-24. GROUNDWATER ELEVATION CONTOURS, DEEP OVERBURDEN, AUGUST 1995

Locations for All Features Shown are Approximate

fig3-P.aml July 1996

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

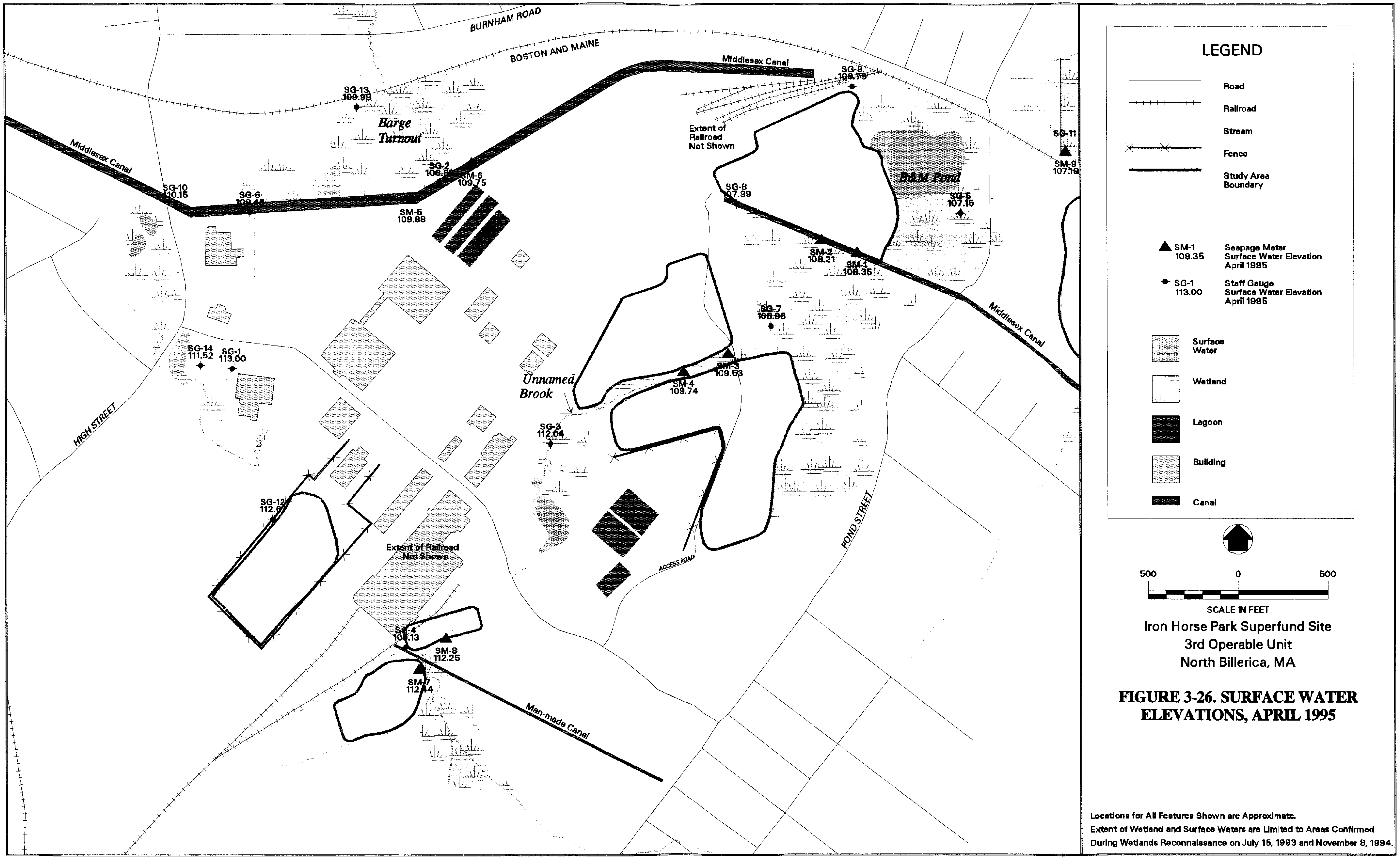
FIGURE 3-25. GROUNDWATER ELEVATION CONTOURS, SHALLOW OVERBURDEN, AUGUST 1995

Locations for All Features Shown are Approximate

fig3-q.aml July 1996

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 3-26. SURFACE WATER ELEVATIONS, APRIL 1995

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

aprsgsm.aml July 1996

Original includes color coding.

Metcalf & Eddy

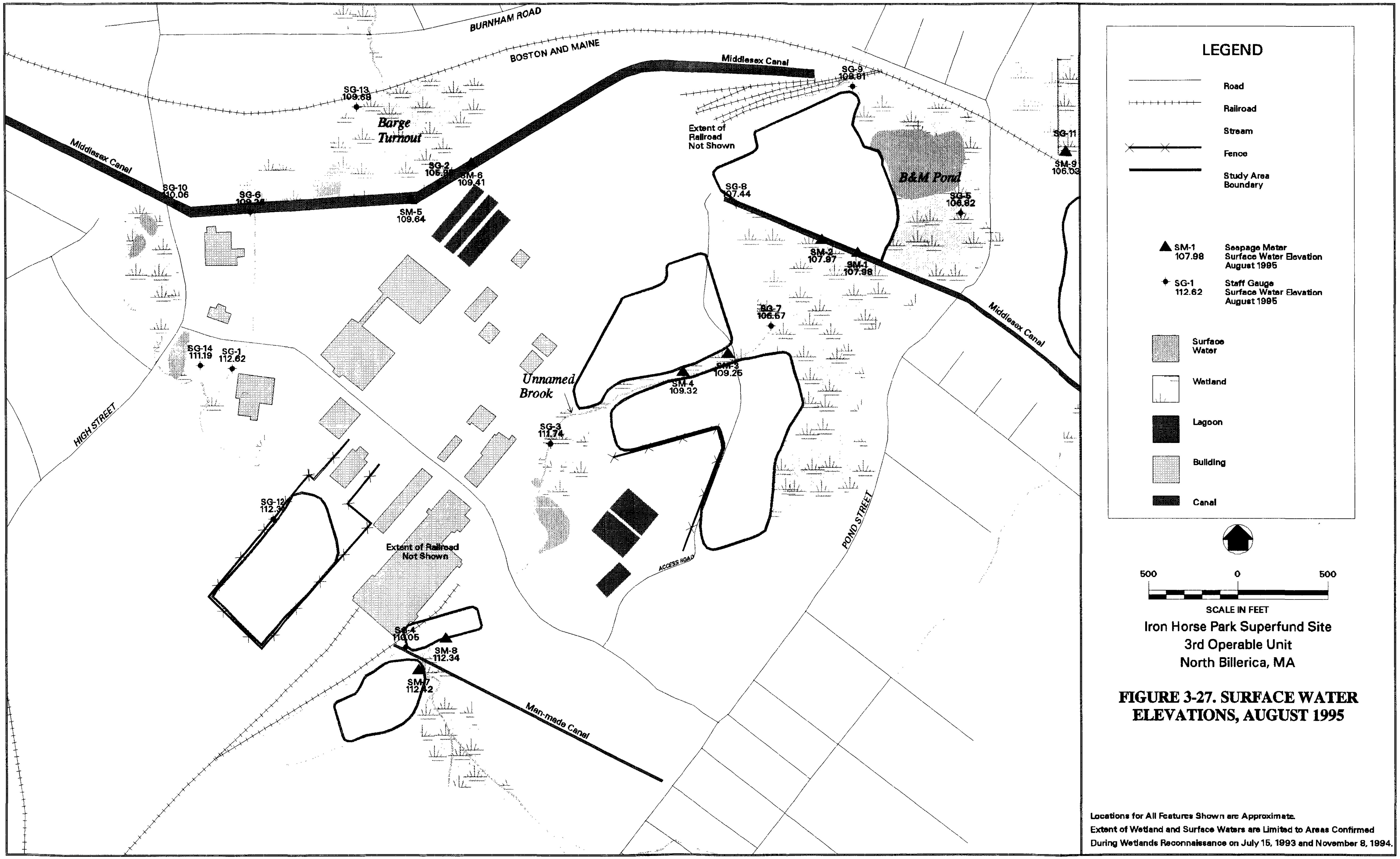
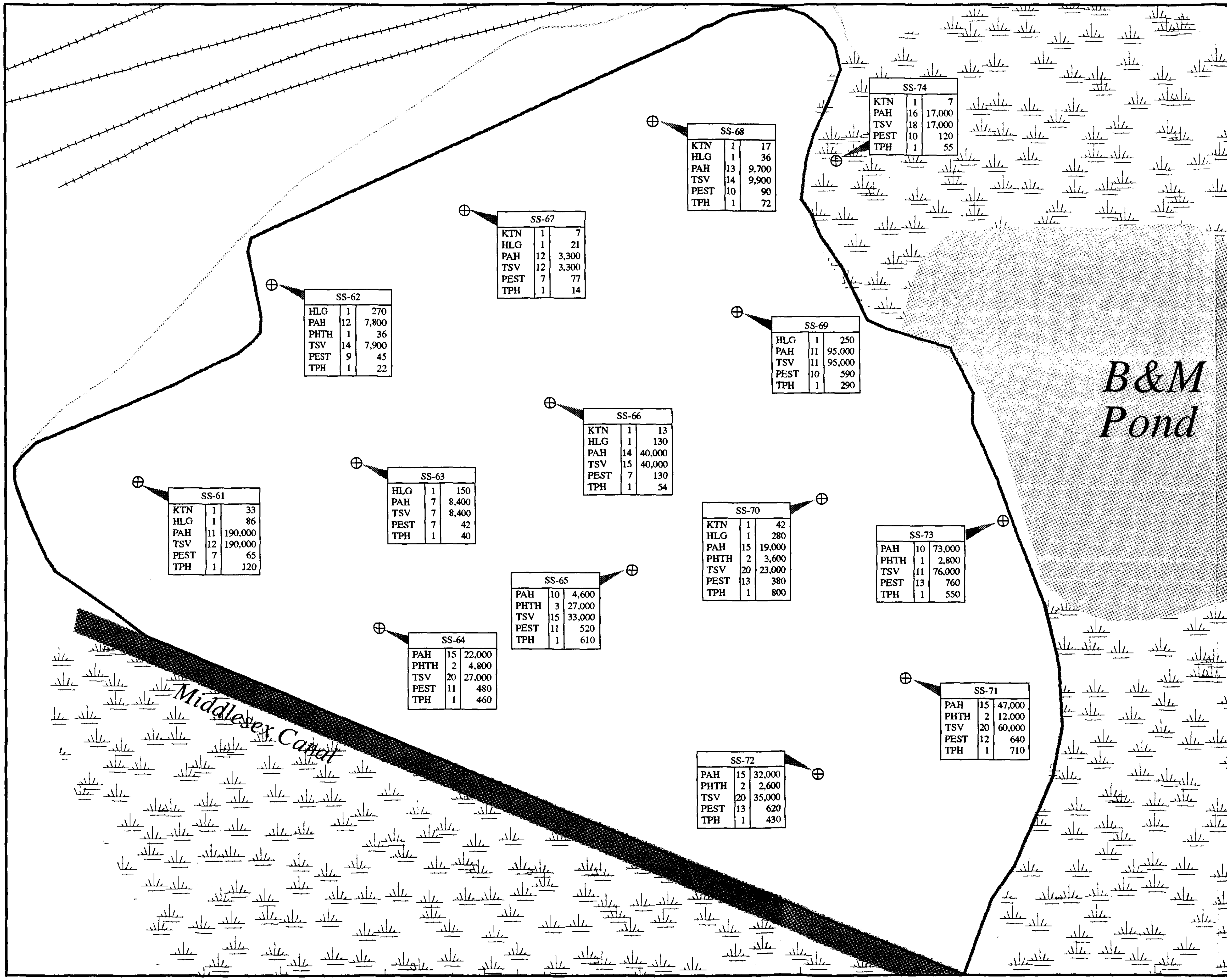


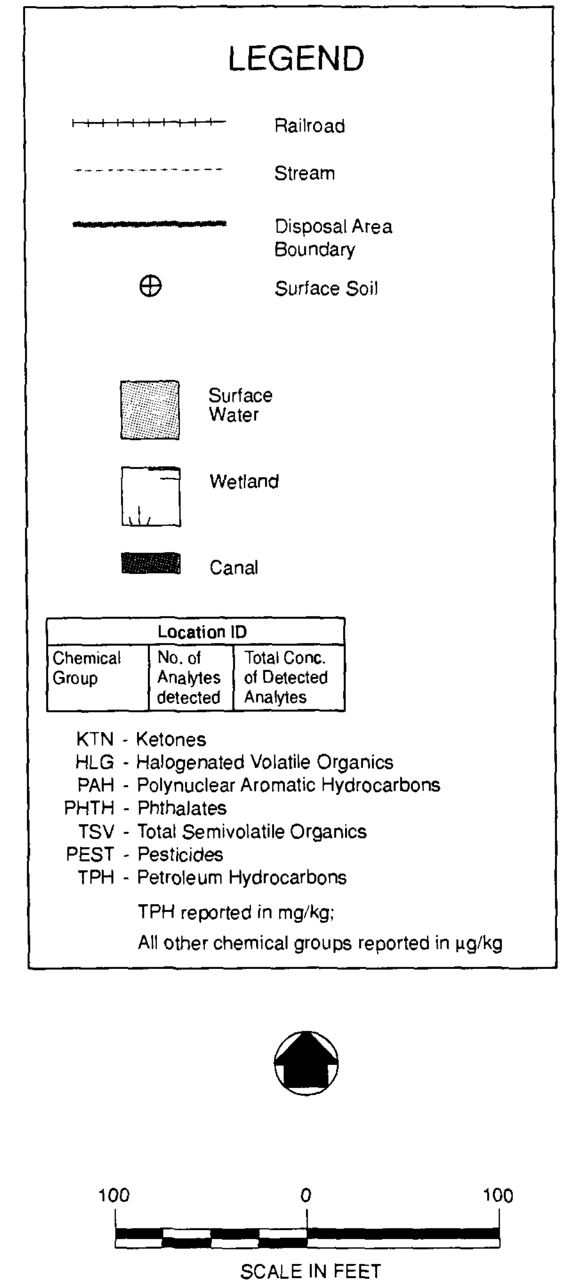
FIGURE 3-27. SURFACE WATER ELEVATIONS, AUGUST 1995

augsgem.aml July 1996

Original includes color coding.

Metcalf & Eddy





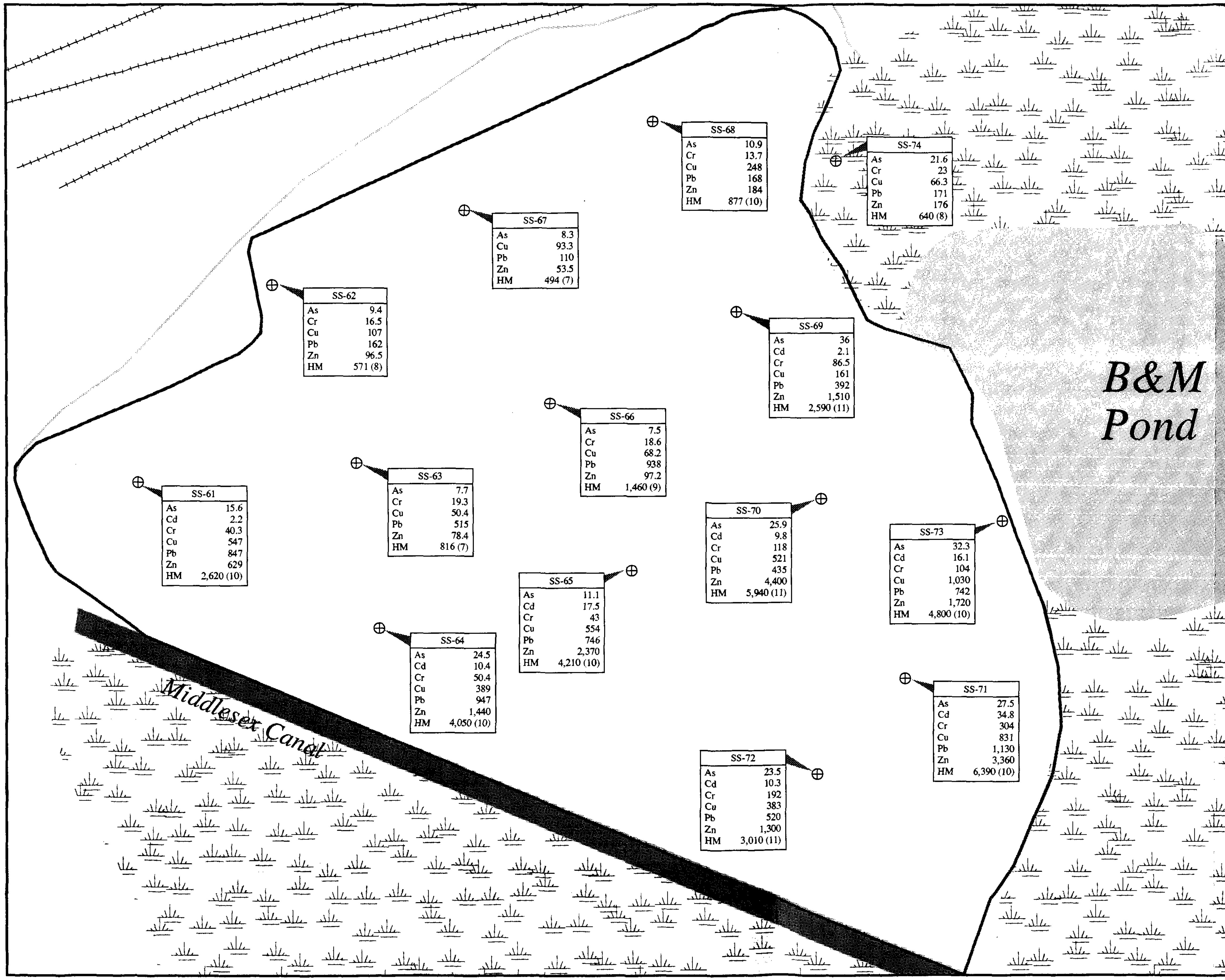
Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 4-1. ORGANIC COMPOUNDS DETECTED IN SURFACE SOIL - B&M RAILROAD LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-1/OrgnoSrf/Soil/BMRRLndfl

Original includes color coding.



LEGEND

Railroad

Stream

Disposal Area Boundary

Surface Soil

Surface Water

Wetland

Canal

HM - Heavy Metals
(#) - Number of heavy metals detected
Concentrations reported in mg/kg
* - Not all detected metals are shown

100 0 100
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 4-2. METALS DETECTED IN SURFACE SOIL - B&M RAILROAD LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-2/Metals/SrfcSoil/BMRRLndfl

Original includes color coding.

Metcalf & Eddy

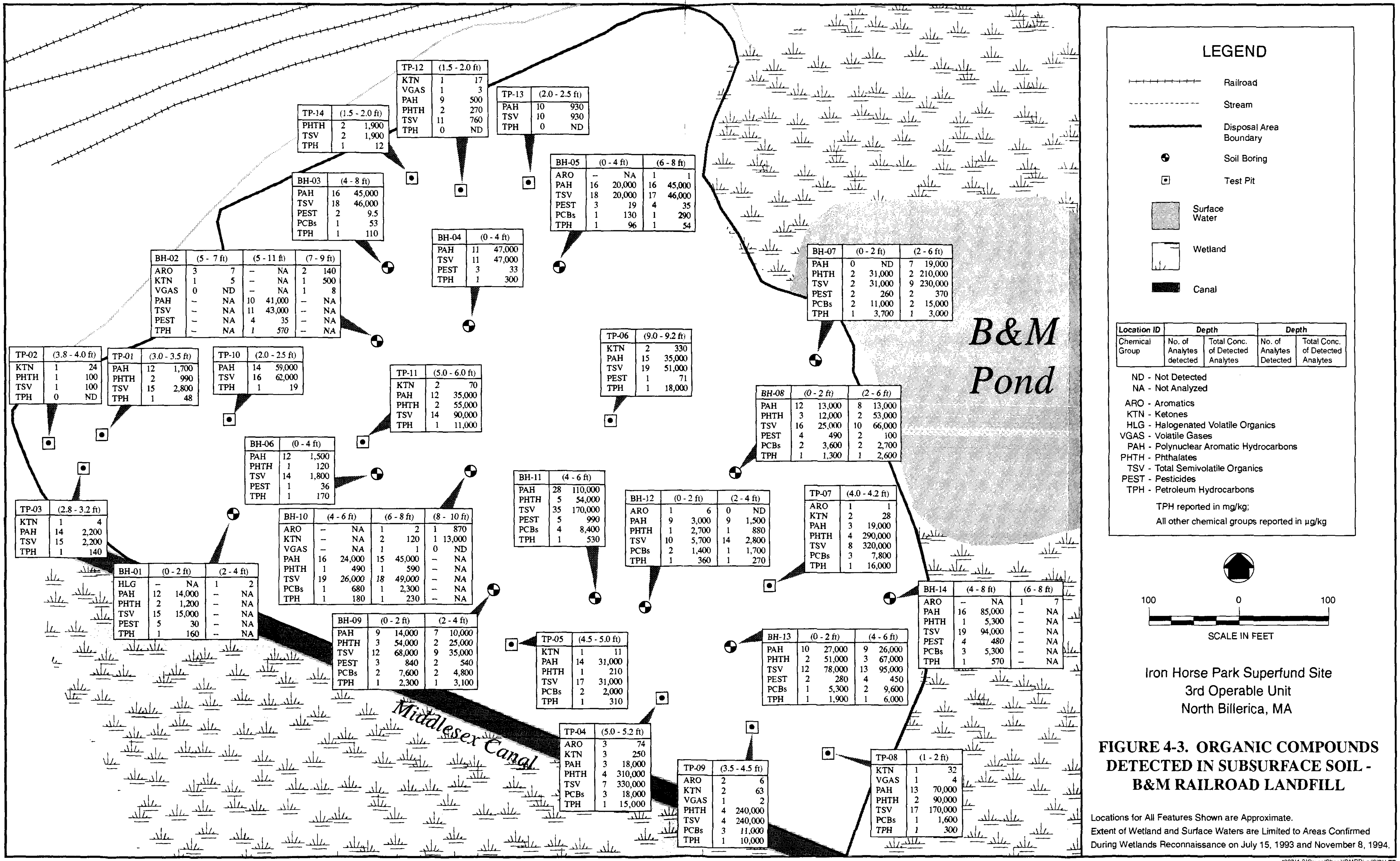


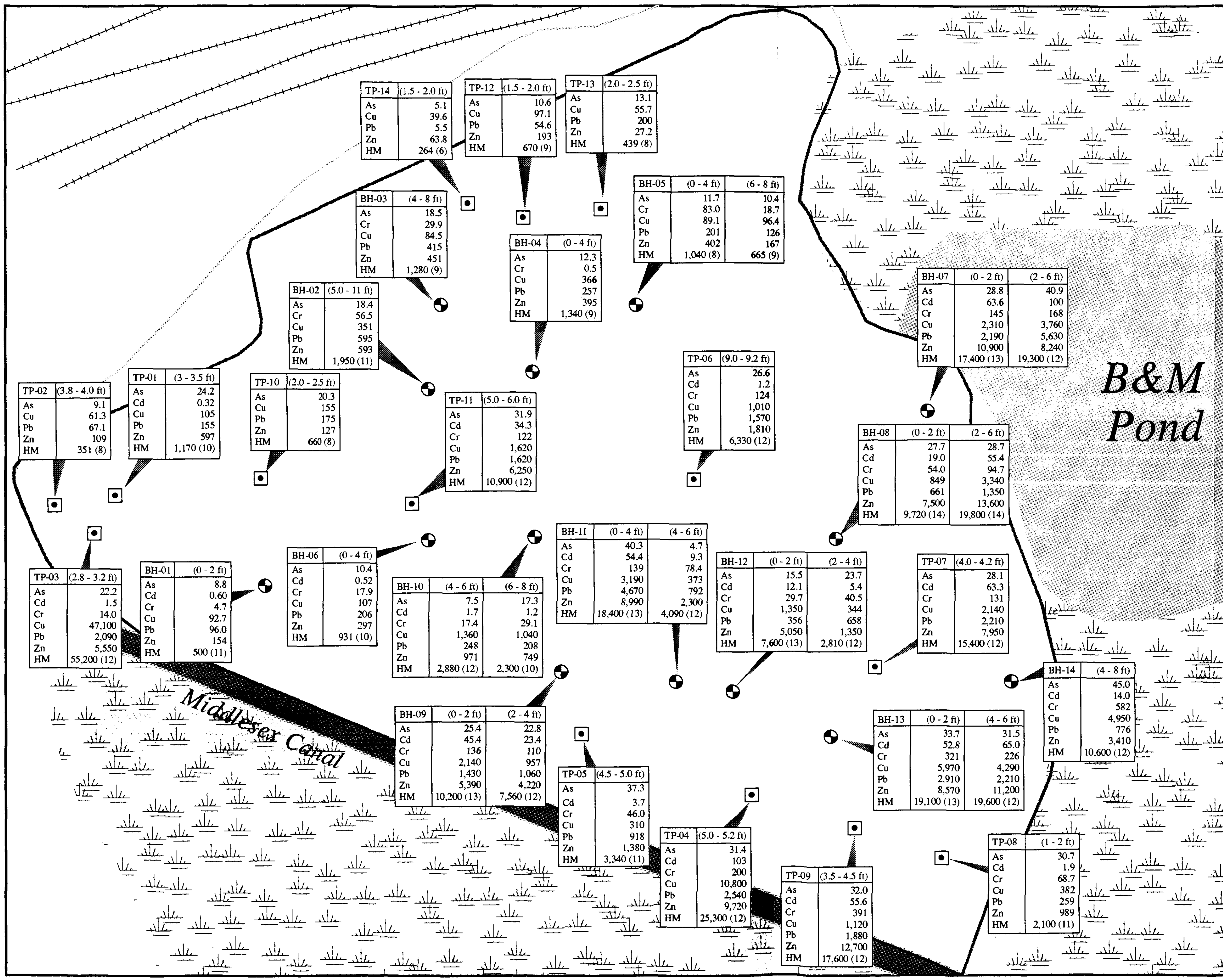
FIGURE 4-3. ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL - B&M RAILROAD LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-3/Orgnc/Sbsoil/BMRRLndfl/BH,TP

Original includes color coding.

Metcalf & Eddy



LEGEND

Railroad

Stream

Disposal Area Boundary

Soil Boring

Test Pit

Surface Water

Wetland

Canal

HM - Heavy Metals
(#) - Number of heavy metals detected
Concentrations reported in mg/kg
* - Not all detected metals are shown

100 0 100
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

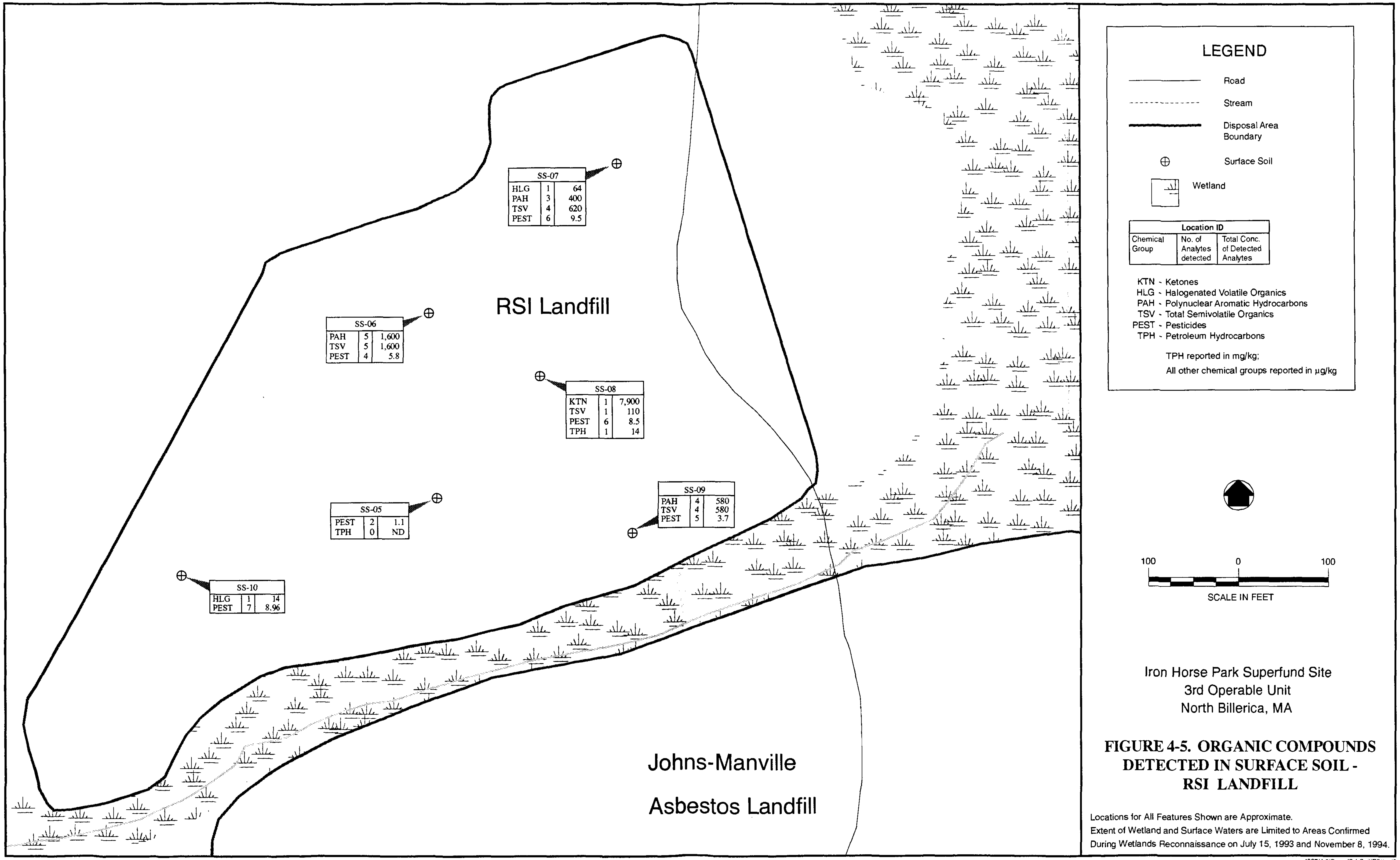
FIGURE 4-4. METALS DETECTED IN SUBSURFACE SOIL - B&M RAILROAD LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-4/Mtls/Sbsoil/BMRRLndfl/BH,TP

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

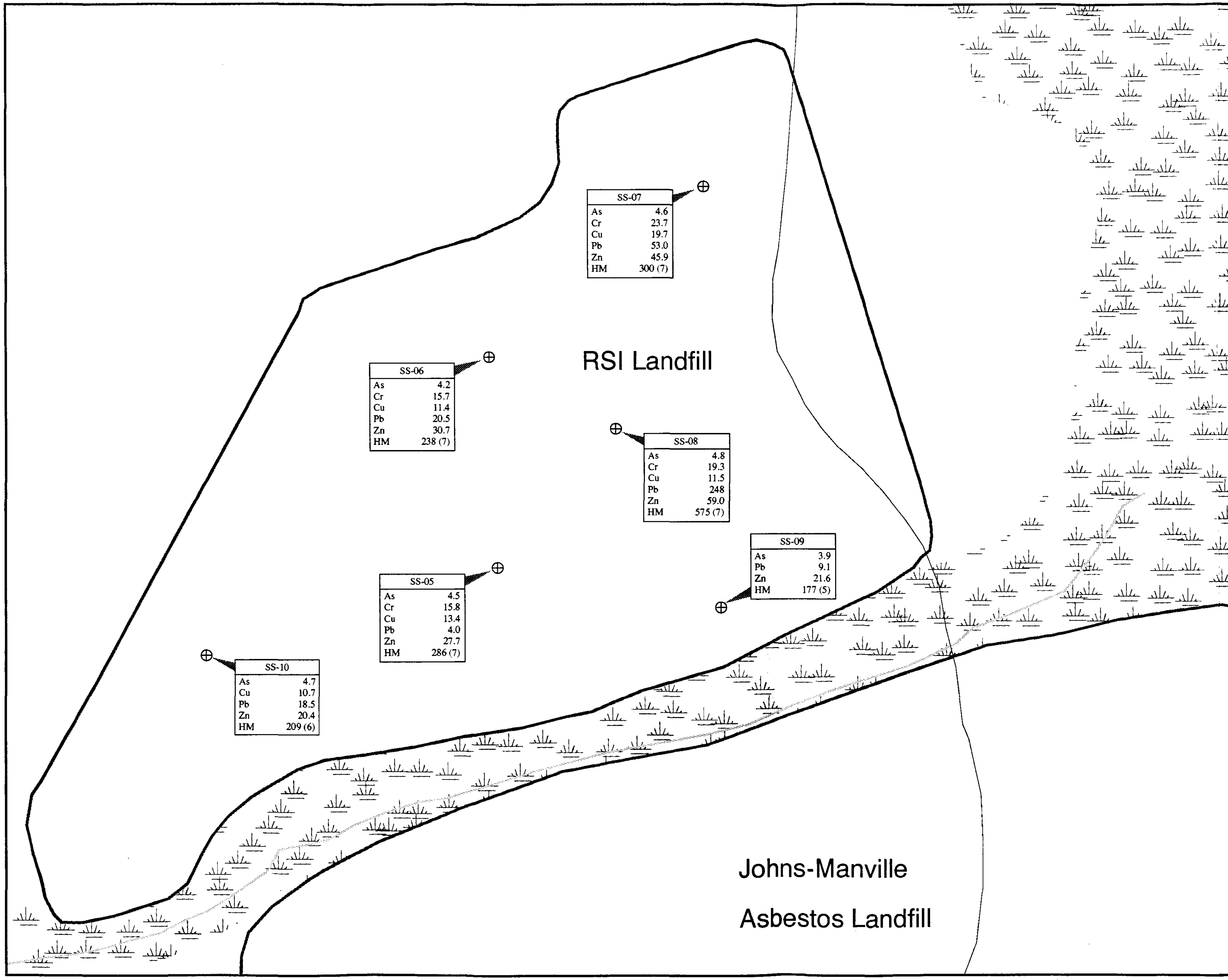
FIGURE 4-5. ORGANIC COMPOUNDS DETECTED IN SURFACE SOIL - RSI LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-5/Orgnc/SrfcSoil/RSILndfl

Original includes color coding.

Metcalf & Eddy



LEGEND

Road

Stream

Disposal Area Boundary

Surface Soil

Wetland

HM - Heavy Metals

(#) - Number of heavy metals detected

Concentrations reported in mg/kg

* - Not all detected metals are shown

100 0 100

SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

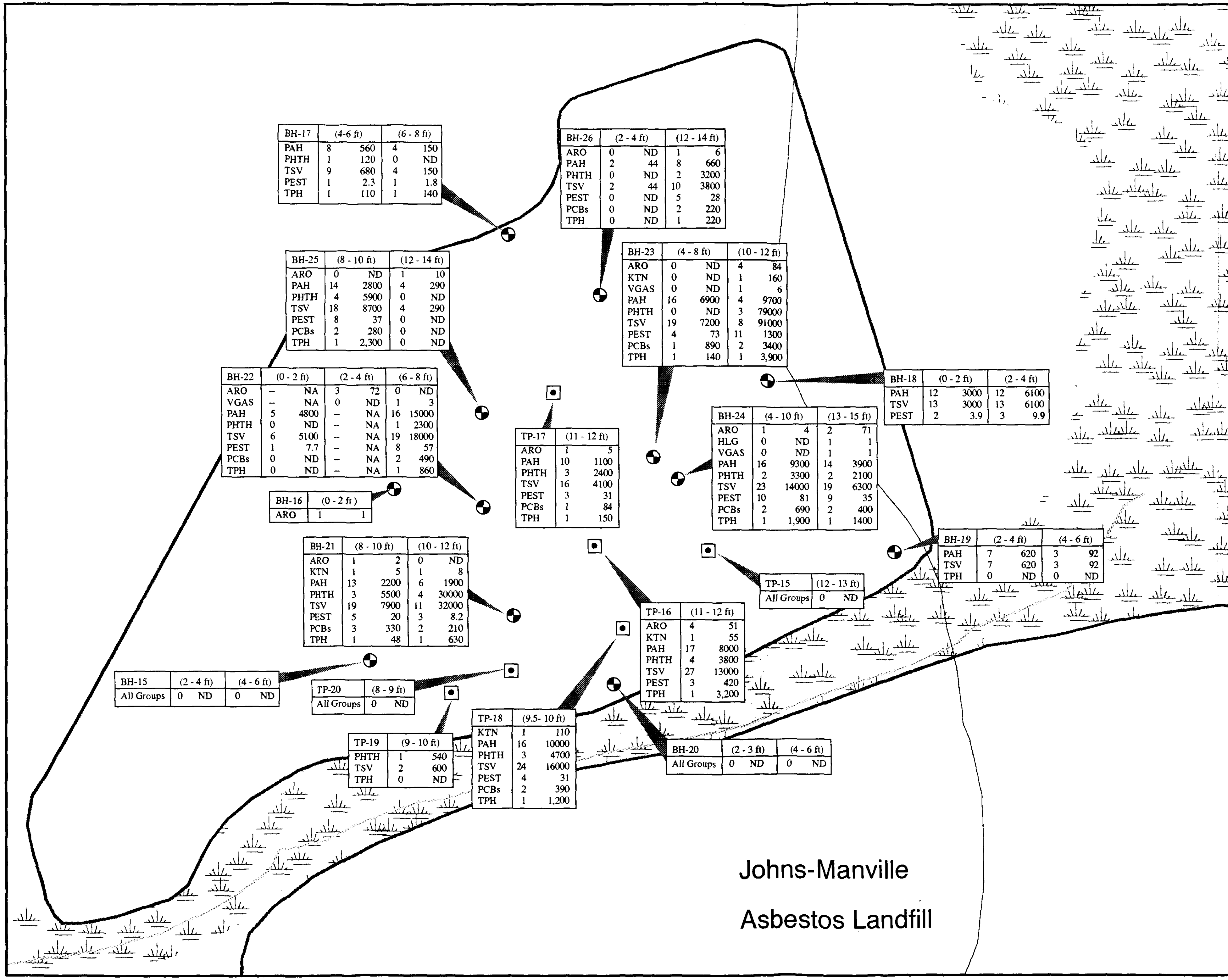
FIGURE 4-6. METALS DETECTED IN SURFACE SOIL - RSI LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-6/Metals/SrfcSoil/RSILndfl

Original includes color coding.

Metcalf & Eddy



LEGEND

Road

Disposal Area Boundary

Soil Boring

Test Pit

Wetland

Location ID	Depth		Depth	
Chemical Group	No. of Analytes detected	Total Conc. of Detected Analytes	No. of Analytes Detected	Total Conc. of Detected Analytes

ND - Not Detected
NA - Not Analyzed

ARO - Aromatics
KTN - Ketones
HLG - Halogenated Volatile Organics
VGAS - Volatile Gases
PAH - Polynuclear Aromatic Hydrocarbons
PHTH - Phthalates
TSV - Total Semivolatile Organics
PEST - Pesticides
TPH - Petroleum Hydrocarbons

TPH reported in mg/kg;
All other chemical groups reported in µg/kg

100 0 100
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

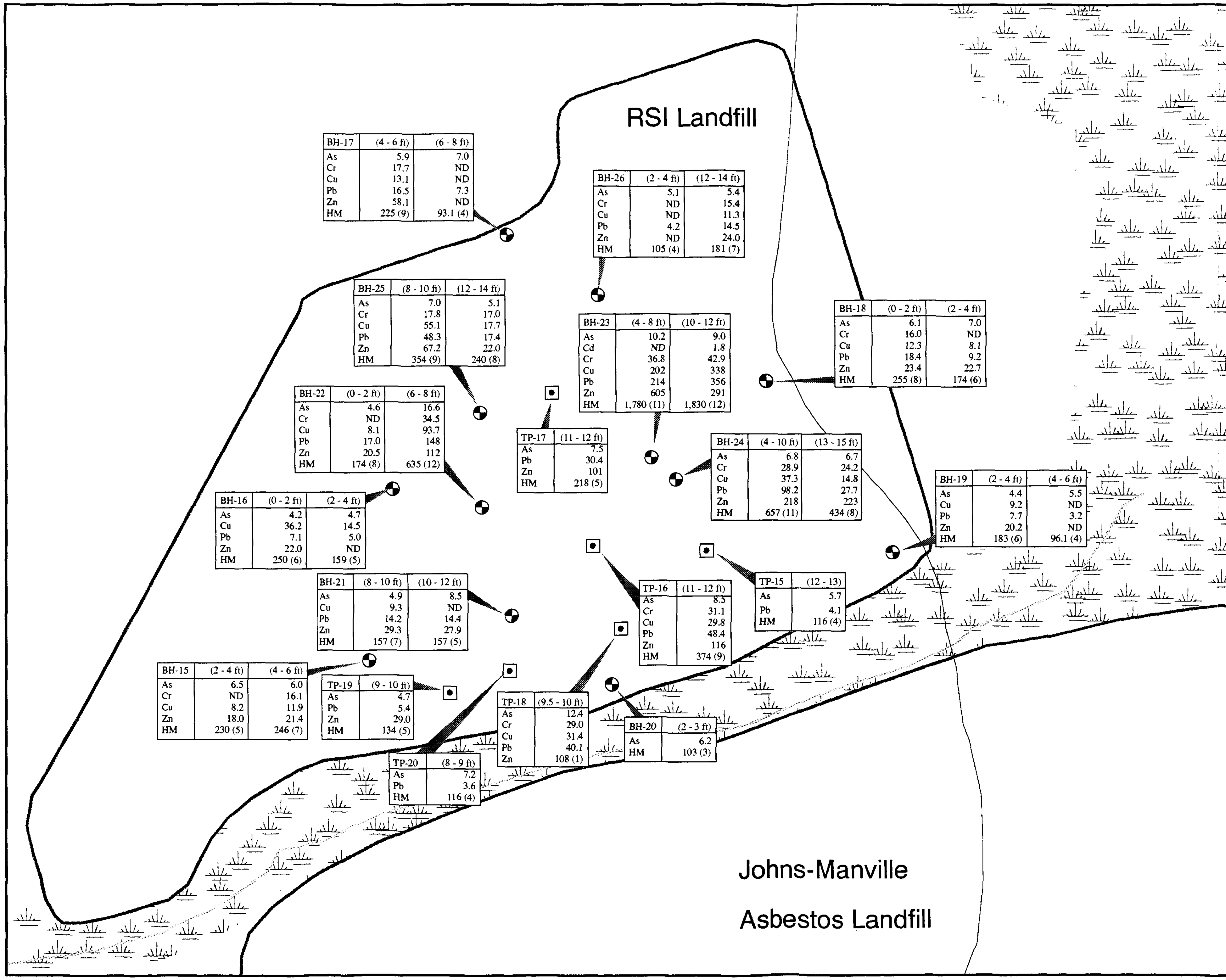
FIGURE 4-7. ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL - RSI LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-7/Orgnc/Sbsoil/RSILndfl/BH,TP

Original includes color coding.

Metcalf & Eddy



LEGEND

Road

Disposal Area Boundary

Soil Boring

Test Pit

Wetland

HM - Heavy Metals
(#) - Number of heavy metals detected
Concentrations reported in mg/kg
* - Not all detected metals are shown
ND - Not Detected

100 0 100
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

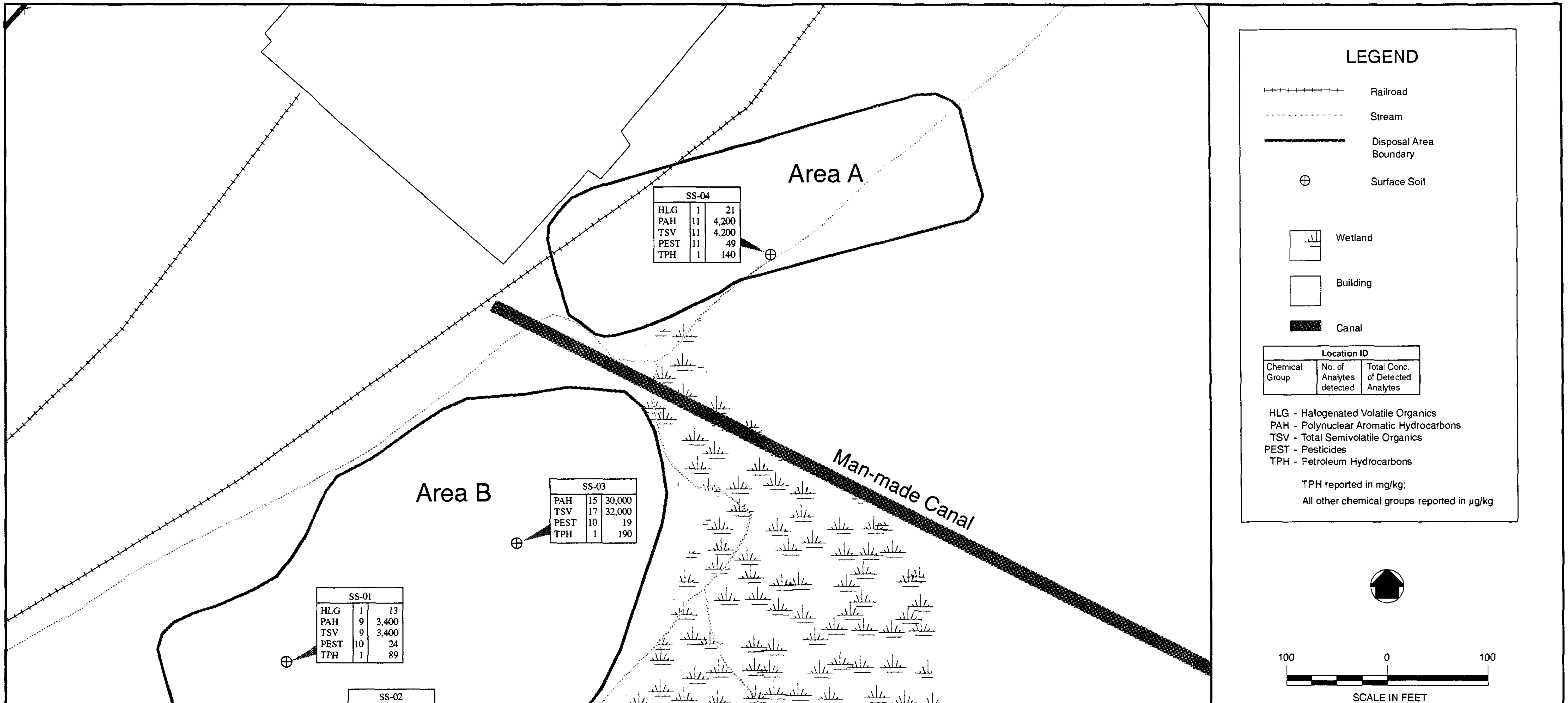
FIGURE 4-8. METALS DETECTED IN SUBSURFACE SOIL - RSI LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4967/4-8/Mtls/Sbsoil/RSILndfl/BH,TP

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

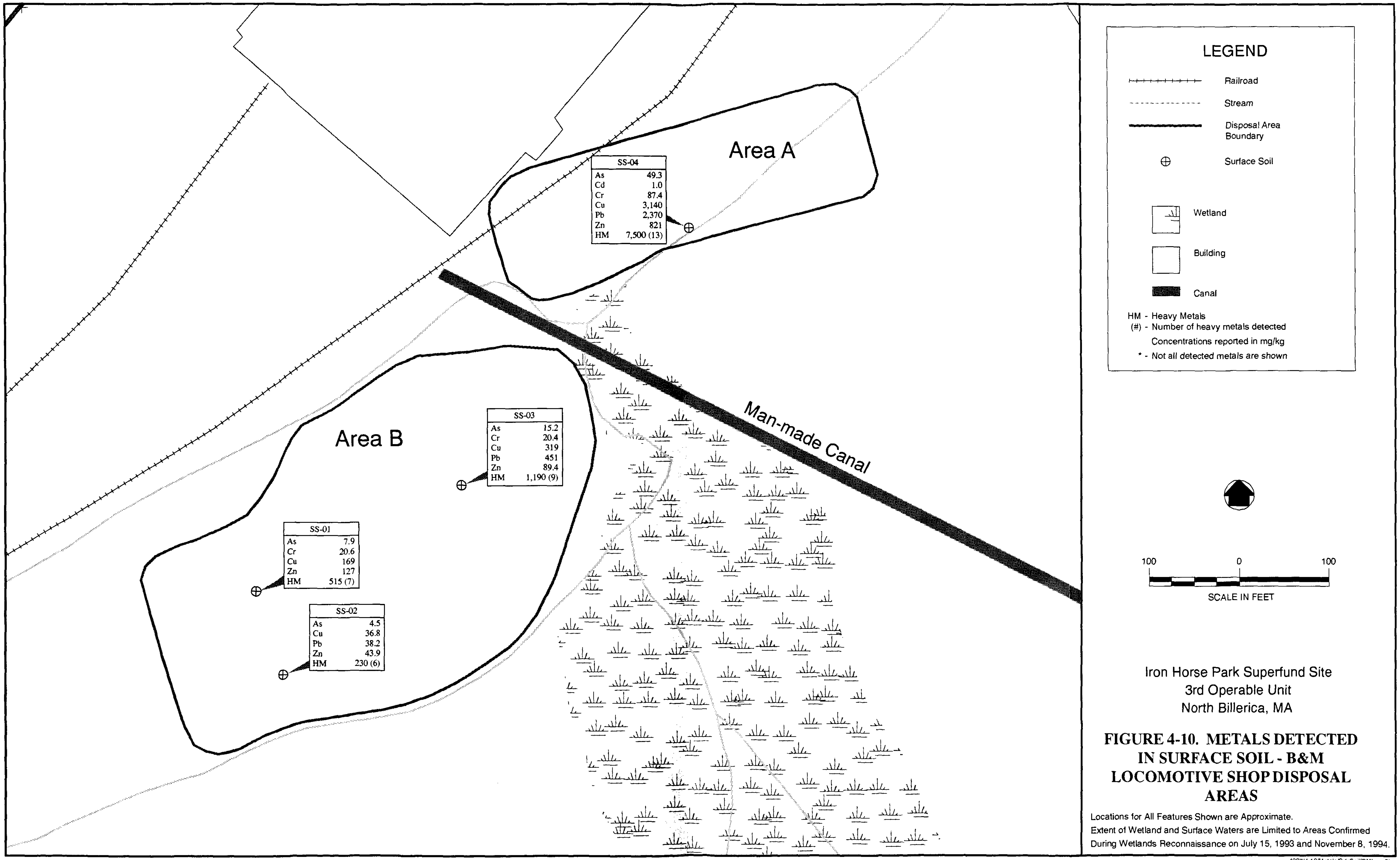
FIGURE 4-9. ORGANIC COMPOUNDS DETECTED IN SURFACE SOIL - B&M LOCOMOTIVE SHOP DISPOSAL AREAS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4967/4-9/Orgnc/SrfcSoil/BMLocoShp

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

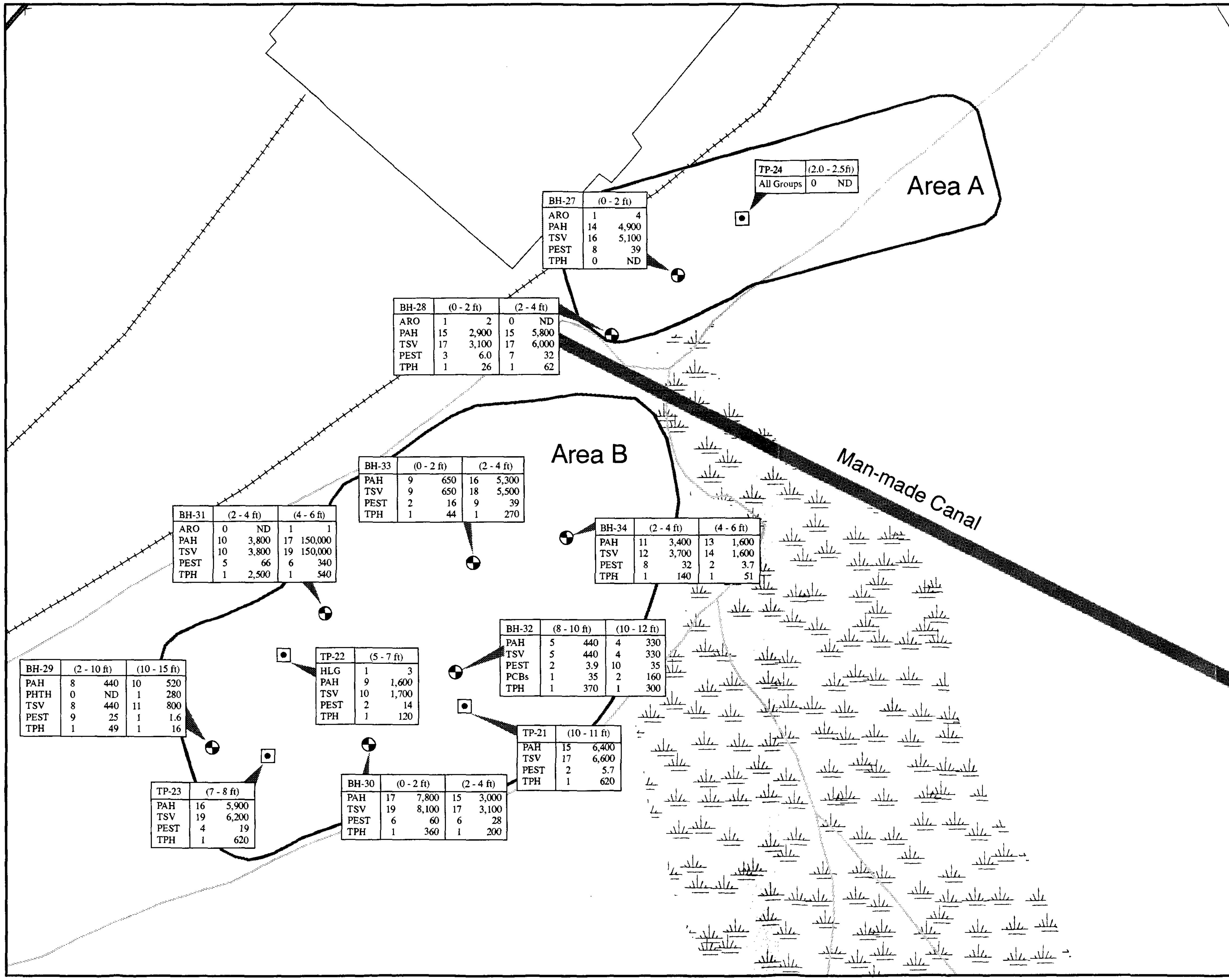
FIGURE 4-10. METALS DETECTED IN SURFACE SOIL - B&M LOCOMOTIVE SHOP DISPOSAL AREAS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-10/Metals/SrfcSoil/BMLocoShp

Original includes color coding.

Metcalf & Eddy



LEGEND

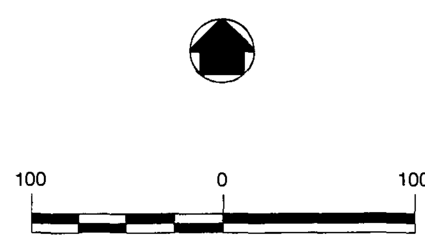
- Railroad
- Stream
- Disposal Area Boundary
- Soil Boring
- Test Pit
- Wetland
- Building
- Canal

Location ID	Depth		Depth	
Chemical Group	No. of Analytes detected	Total Conc. of Detected Analytes	No. of Analytes Detected	Total Conc. of Detected Analytes

ND - Not Detected

ARO - Aromatics
HLG - Halogenated Volatile Organics
PAH - Polynuclear Aromatic Hydrocarbons
PHTH - Phthalates
TSV - Total Semivolatile Organics
PEST - Pesticides
TPH - Petroleum Hydrocarbons

TPH reported in mg/kg;
All other chemical groups reported in µg/kg



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

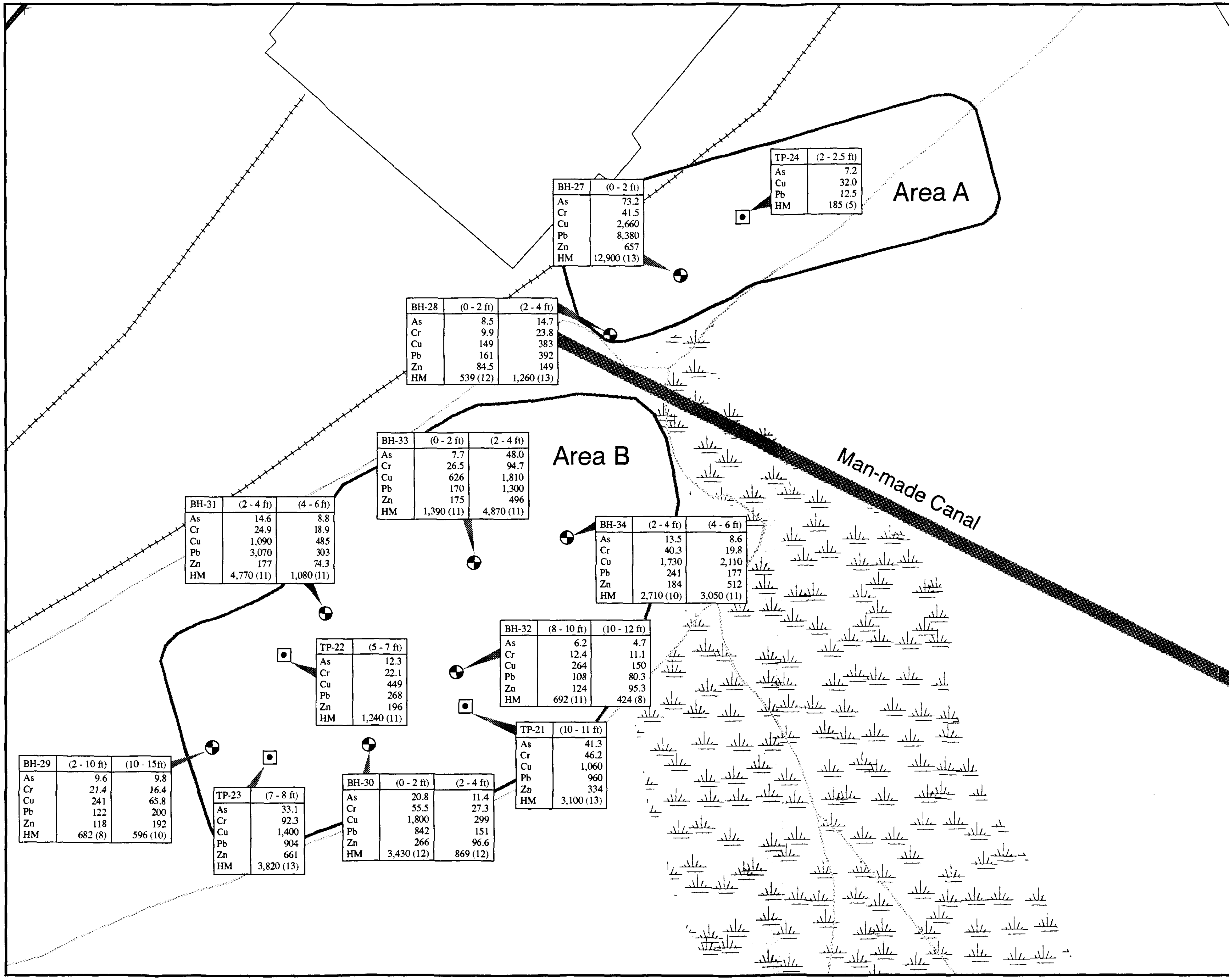
FIGURE 4-11. ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL - B&M LOCOMOTIVE SHOP DISPOSAL AREAS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-11/Orgnc/Sbsoil/BMLocoShp/BH,TP

Original includes color coding.

Metcalf & Eddy



LEGEND

Railroad
Stream
Disposal Area Boundary
Soil Boring
Test Pit
Wetland
Building
Canal

HM - Heavy Metals
(#) - Number of heavy metals detected
Concentrations reported in mg/kg
* - Not all detected metals are shown

100 0 100
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

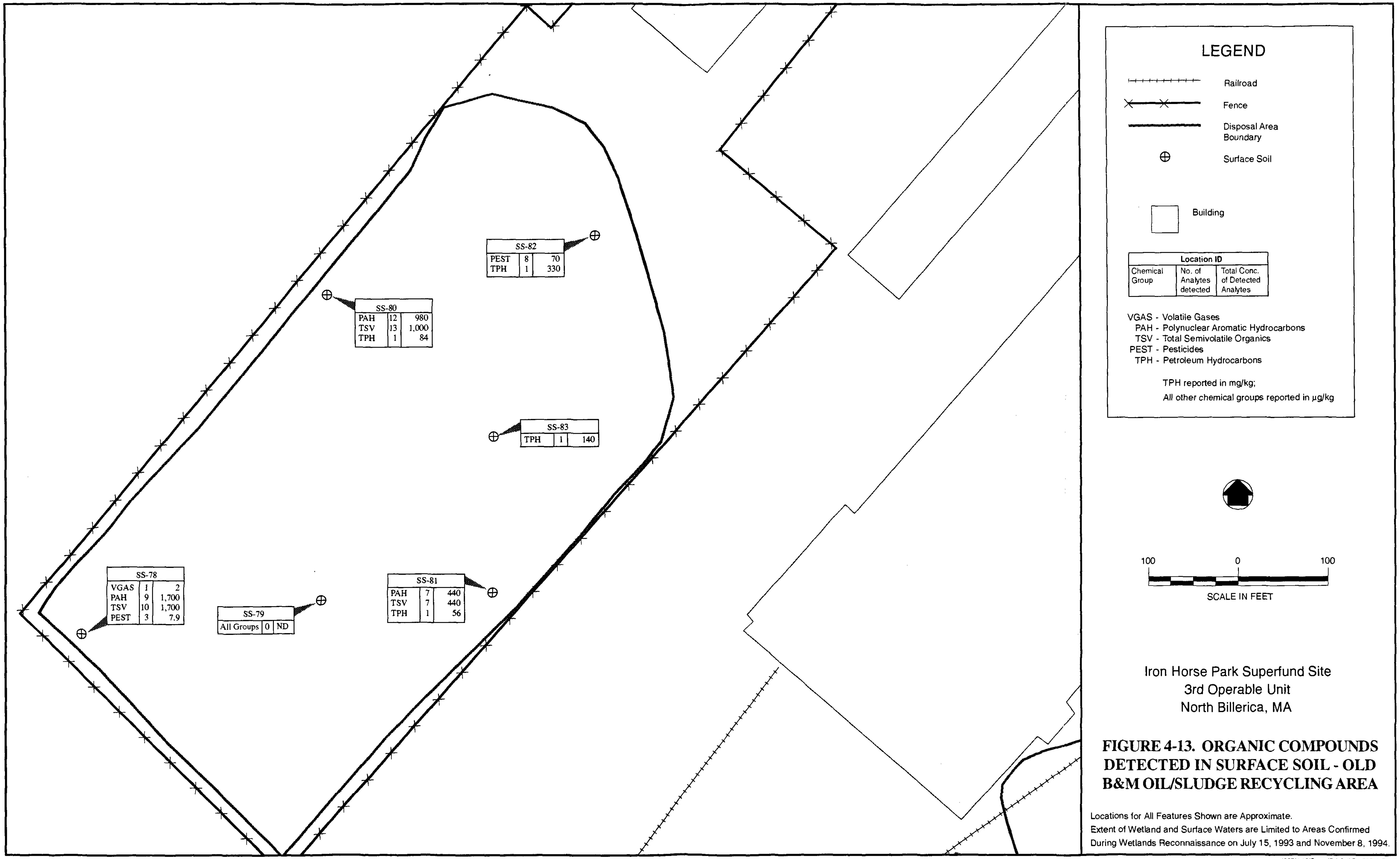
FIGURE 4-12. METALS DETECTED IN SUBSURFACE SOIL - B&M LOCOMOTIVE SHOP DISPOSAL AREAS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-12/Mtls/Sbsoil/BMLocoShp/BH,TP

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

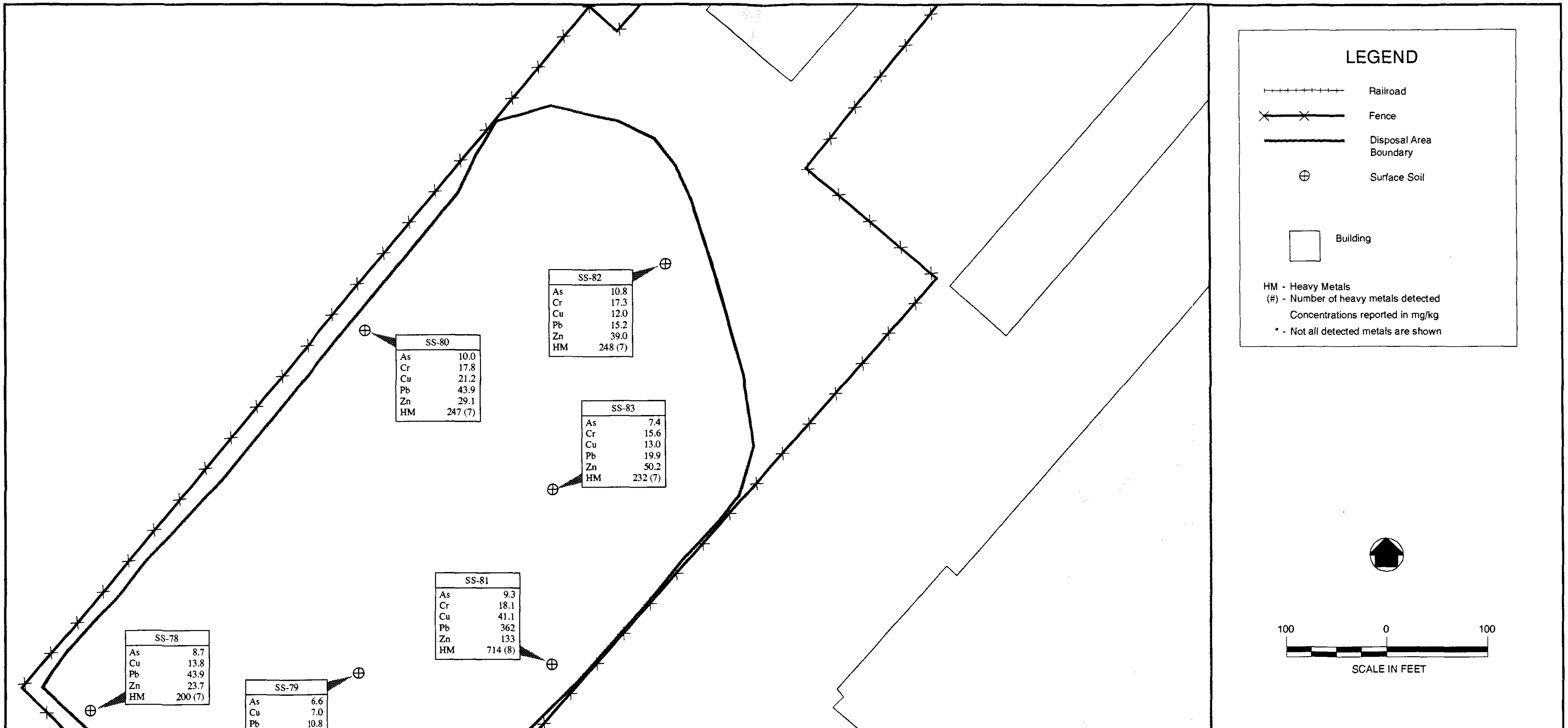
FIGURE 4-13. ORGANIC COMPOUNDS DETECTED IN SURFACE SOIL - OLD B&M OIL/SLUDGE RECYCLING AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-13/Orgnc/SrfcSoil/BMOilSldgRcycl

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

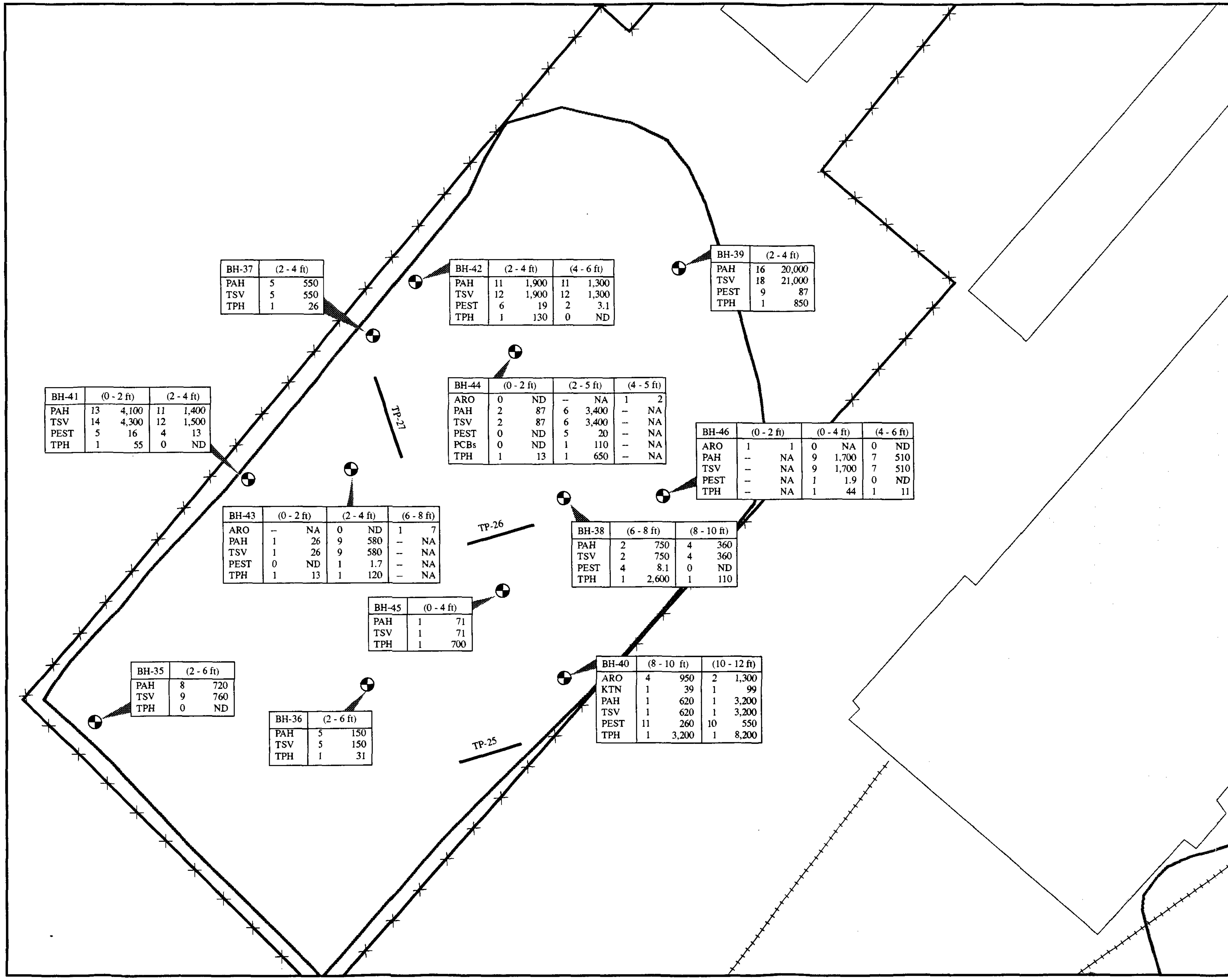
FIGURE 4-14. METALS DETECTED IN SURFACE SOIL - OLD B&M OIL/SLUDGE RECYCLING AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-14/Metals/SrfcSoil/BMOilSldgRcycl

Original includes color coding.

Metcalf & Eddy



BH-37	(2 - 4 ft)	
PAH	5	550
TSV	5	550
TPH	1	26

BH-42	(2 - 4 ft)		(4 - 6 ft)	
PAH	11	1,900	11	1,300
TSV	12	1,900	12	1,300
PEST	6	19	2	3.1
TPH	1	130	0	ND

BH-39	(2 - 4 ft)	
PAH	16	20,000
TSV	18	21,000
PEST	9	87
TPH	1	850

BH-41	(0 - 2 ft)		(2 - 4 ft)	
PAH	13	4,100	11	1,400
TSV	14	4,300	12	1,500
PEST	5	16	4	13
TPH	1	55	0	ND

BH-44	(0 - 2 ft)		(2 - 5 ft)		(4 - 5 ft)	
ARO	0	ND	--	NA	1	2
PAH	2	87	6	3,400	--	NA
TSV	2	87	6	3,400	--	NA
PEST	0	ND	5	20	--	NA
PCBs	0	ND	1	110	--	NA
TPH	1	13	1	650	--	NA

BH-46	(0 - 2 ft)		(0 - 4 ft)		(4 - 6 ft)	
ARO	1	1	0	NA	0	ND
PAH	--	NA	9	1,700	7	510
TSV	--	NA	9	1,700	7	510
PEST	--	NA	1	1.9	0	ND
TPH	--	NA	1	44	1	11

BH-43	(0 - 2 ft)		(2 - 4 ft)		(6 - 8 ft)	
ARO	--	NA	0	ND	1	7
PAH	1	26	9	580	--	NA
TSV	1	26	9	580	--	NA
PEST	0	ND	1	1.7	--	NA
TPH	1	13	1	120	--	NA

BH-38	(6 - 8 ft)		(8 - 10 ft)	
PAH	2	750	4	360
TSV	2	750	4	360
PEST	4	8.1	0	ND
TPH	1	2,600	1	110

BH-45	(0 - 4 ft)	
PAH	1	71
TSV	1	71
TPH	1	700

BH-35	(2 - 6 ft)	
PAH	8	720
TSV	9	760
TPH	0	ND

BH-36	(2 - 6 ft)	
PAH	5	150
TSV	5	150
TPH	1	31

BH-40	(8 - 10 ft)		(10 - 12 ft)	
ARO	4	950	2	1,300
KTN	1	39	1	99
PAH	1	620	1	3,200
TSV	1	620	1	3,200
PEST	11	260	10	550
TPH	1	3,200	1	8,200

LEGEND

Railroad

Fence

Disposal Area Boundary

Soil Boring

Test Pit

Building

Location ID	Depth		Depth	
Chemical Group	No. of Analytes detected	Total Conc. of Detected Analytes	No. of Analytes Detected	Total Conc. of Detected Analytes

ND - Not Detected
NA - Not Analyzed

ARO - Aromatics
PAH - Polynuclear Aromatic Hydrocarbons
TSV - Total Semivolatile Organics
PEST - Pesticides
TPH - Petroleum Hydrocarbons

TPH reported in mg/kg;
All other chemical groups reported in µg/kg

100 0 100

SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 4-15. ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL - OLD B&M OIL/SLUDGE RECYCLING AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-15/OrgCmpndsSubSoil/BMOilSldgRcycl

Original includes color coding.

Metcalf & Eddy

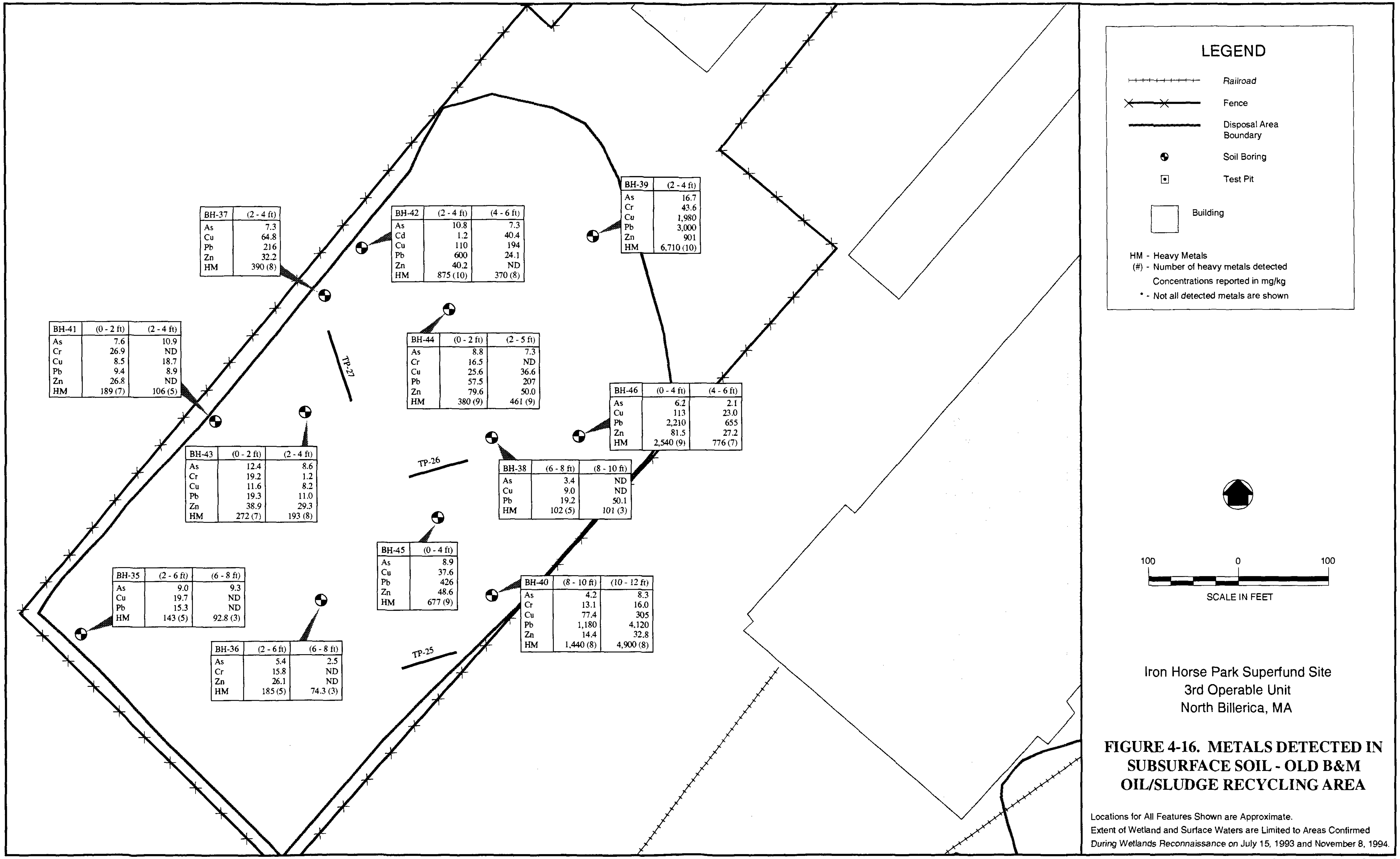


FIGURE 4-16. METALS DETECTED IN SUBSURFACE SOIL - OLD B&M OIL/SLUDGE RECYCLING AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During *Wetlands Reconnaissance* on July 15, 1993 and November 8, 1994.

4987/4-16 /Mtls/Sbsoil/BMOilSldgRcycl/BH,TP

Original includes color coding.

Metcalf & Eddy

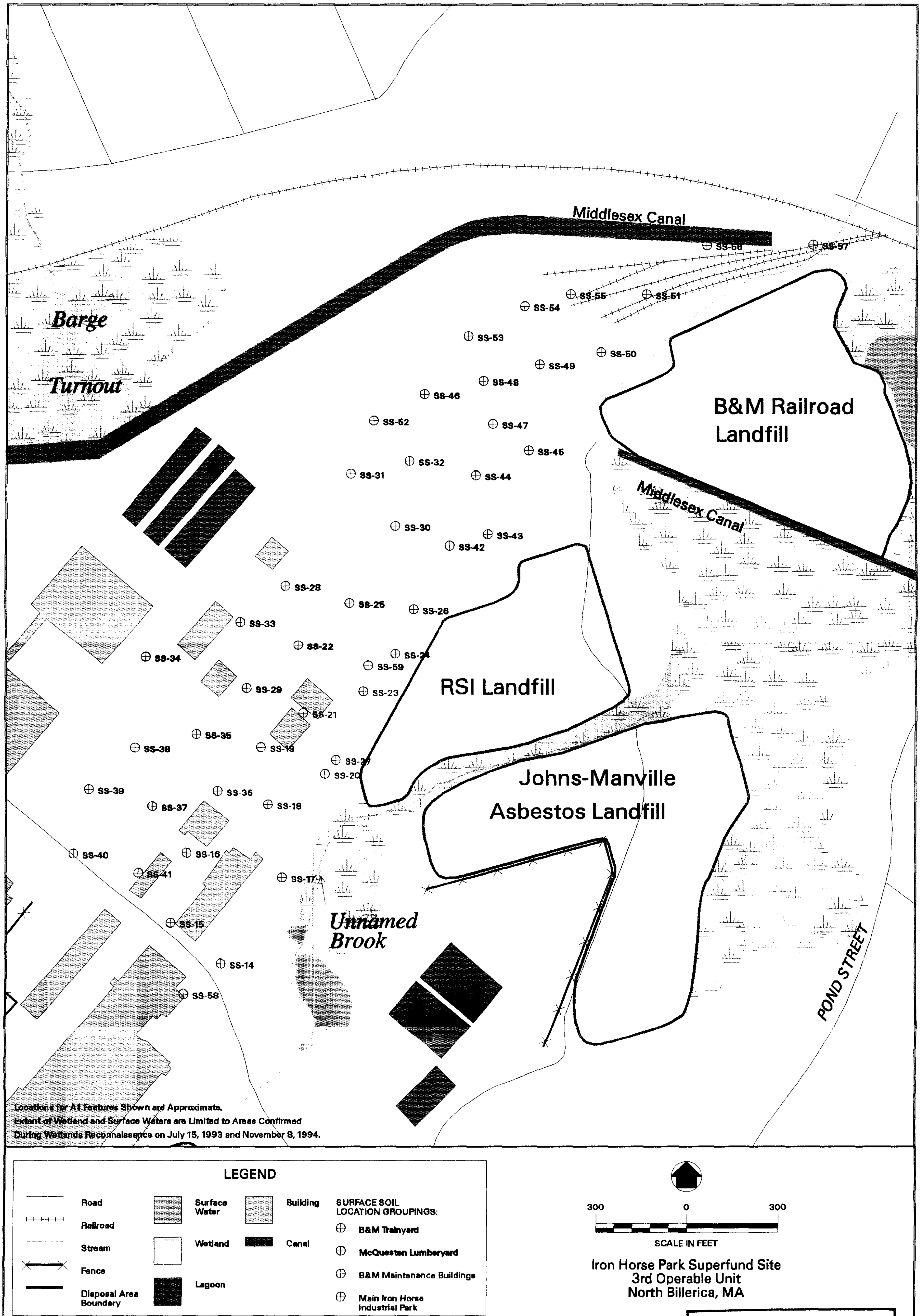
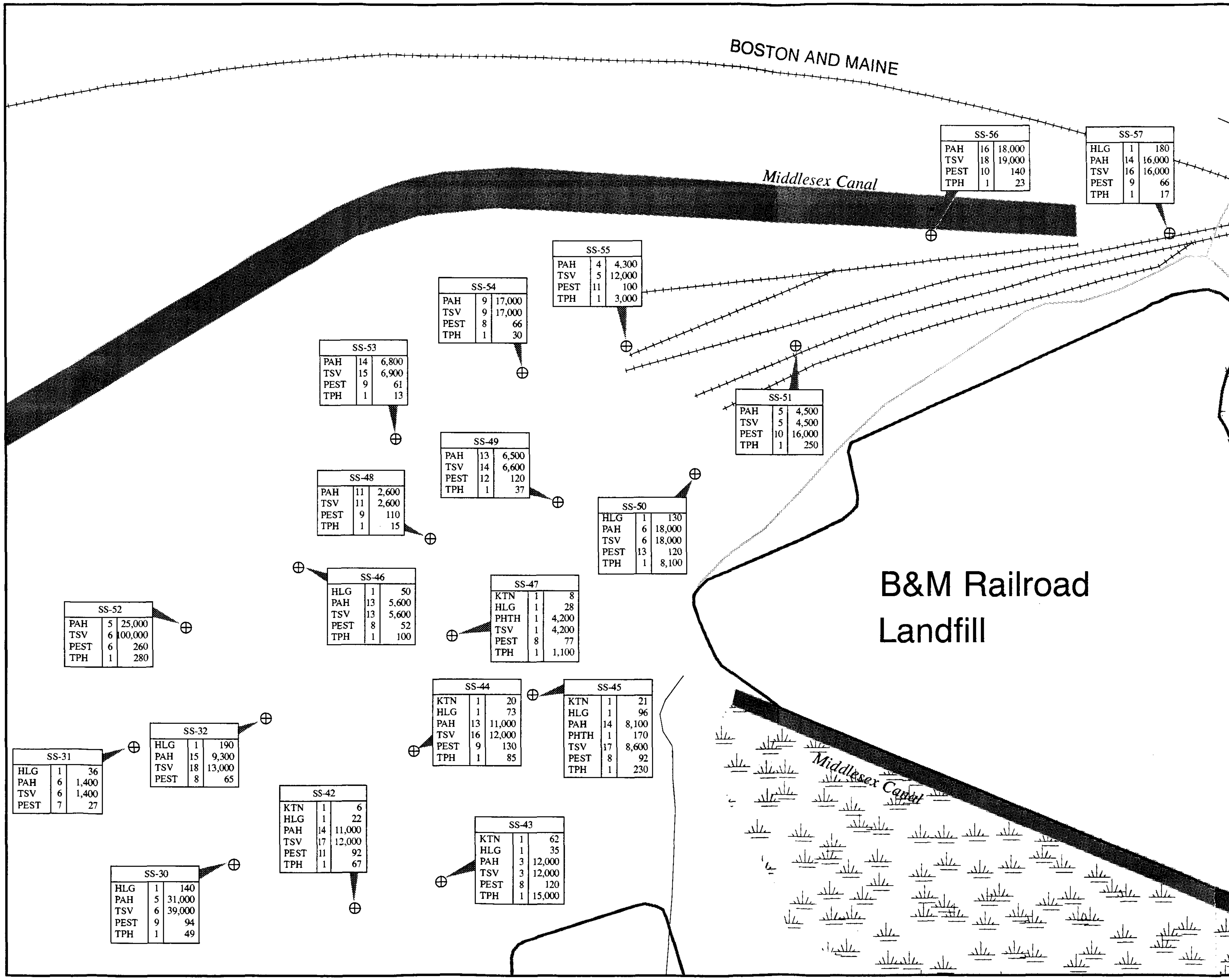


FIGURE 4-17. SURFACE SOIL LOCATION GROUPINGS WITHIN THE CONTAMINATED SOIL AREA

Original includes color coding.



LEGEND

Road

Railroad

Stream

Disposal Area Boundary

Surface Soil

Wetland

Canal

Location ID		
Chemical Group	No. of Analytes detected	Total Conc. of Detected Analytes

KTN - Ketones
HLG - Halogenated Volatile Organics
PAH - Polynuclear Aromatic Hydrocarbons
PHTH - Phthalates
TSV - Total Semivolatile Organics
PEST - Pesticides
TPH - Petroleum Hydrocarbons

TPH reported in mg/kg;
All other chemical groups reported in µg/kg

150 0 150
SCALE IN FEET

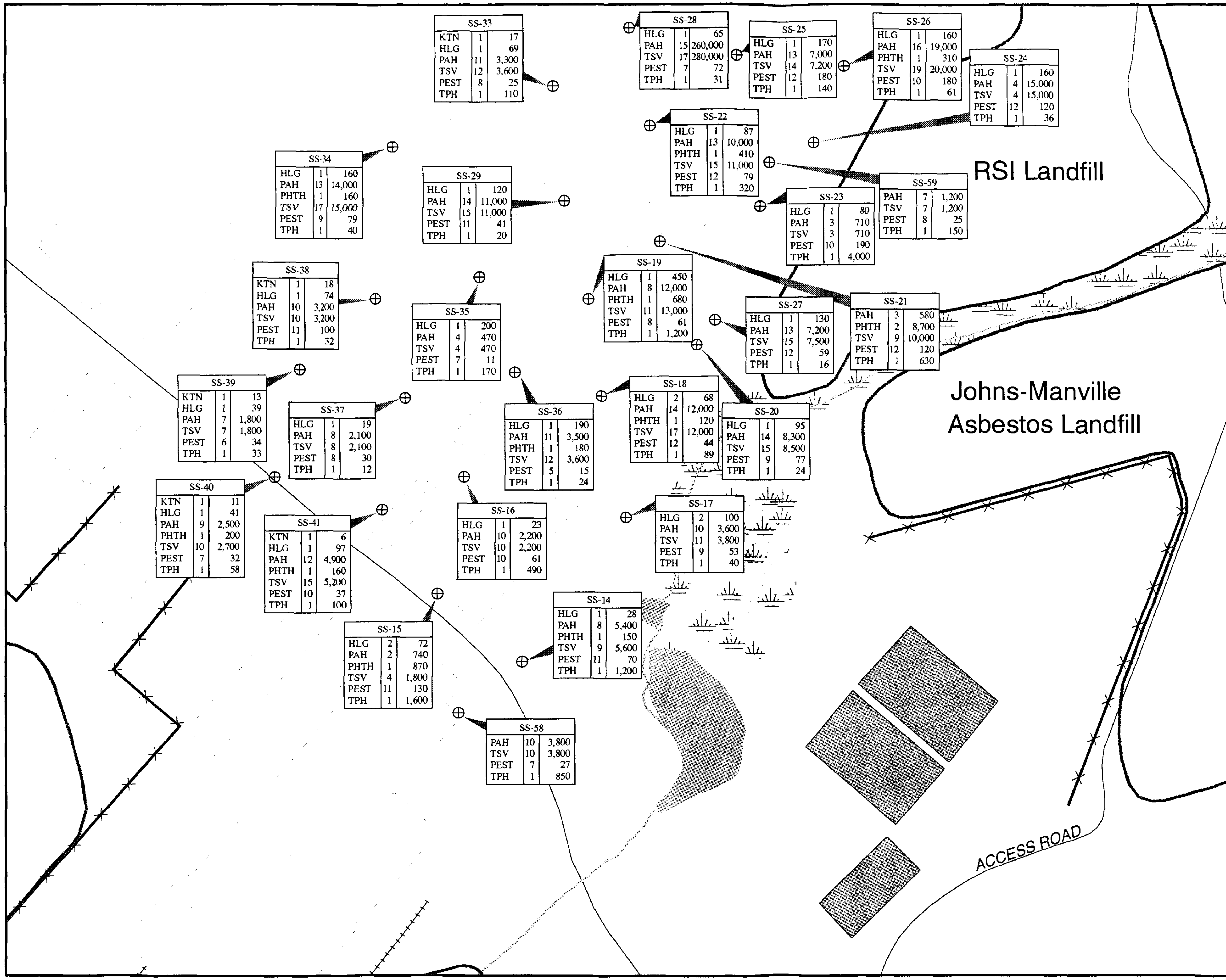
Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 4-18. ORGANIC COMPOUNDS DETECTED IN SURFACE SOIL - NORTHERN CONTAMINATED SOIL AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-18/OrgncSrfcSoilContSoilAreaNorth

Original includes color coding.



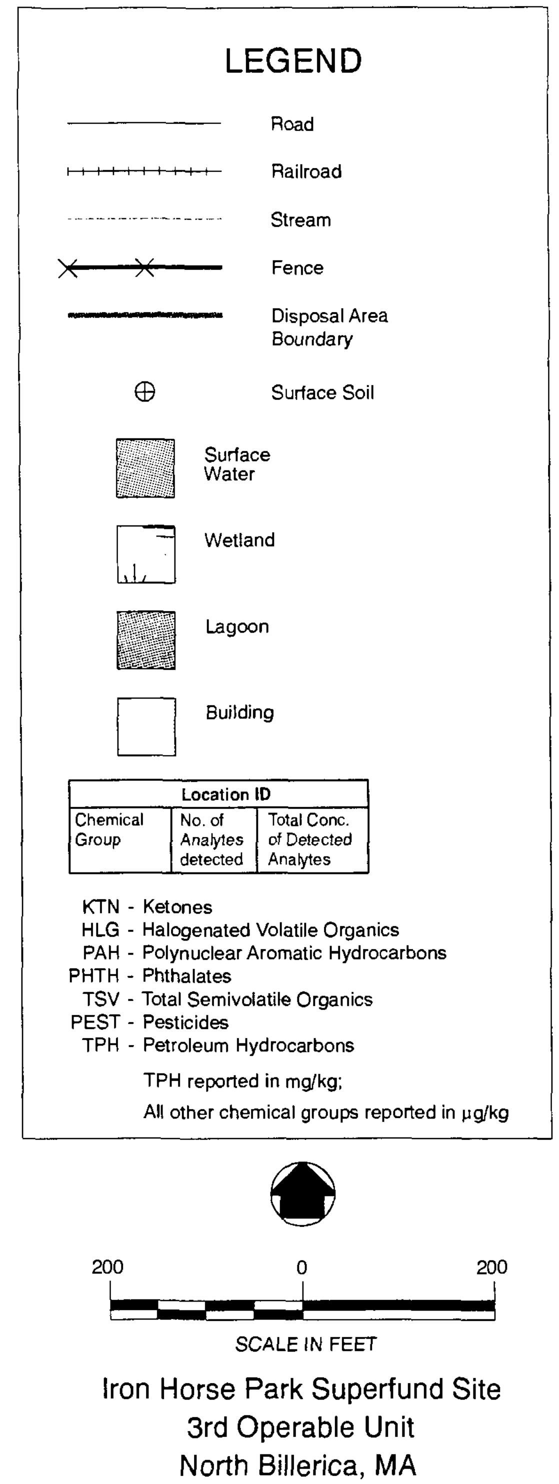
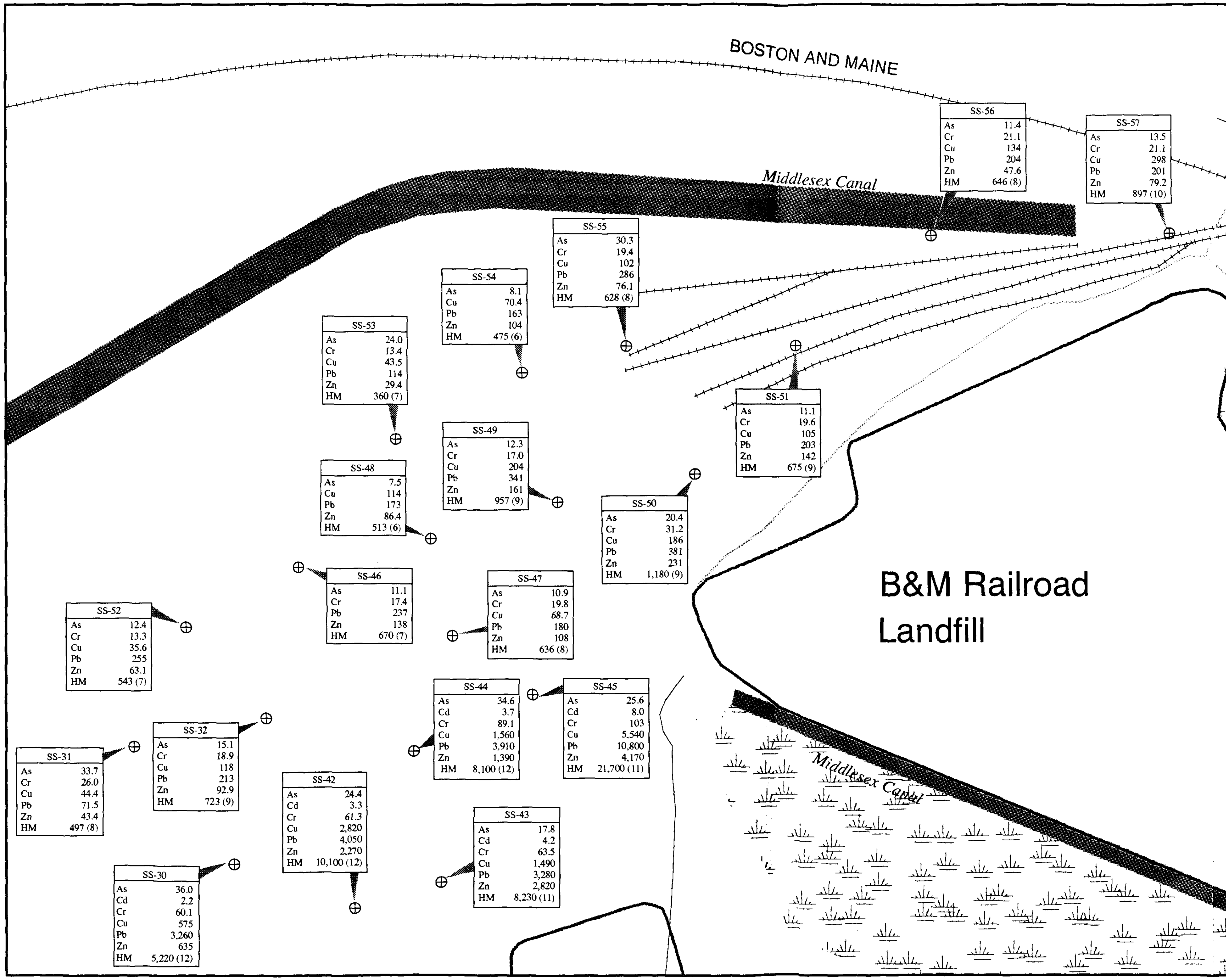


FIGURE 4-19. ORGANIC COMPOUNDS DETECTED IN SURFACE SOIL - SOUTHERN CONTAMINATED SOIL AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-19/Orgnc/SrfcSoil/ContSoilAreaSouth

Original includes color coding.



LEGEND

- Road
- Railroad
- Stream
- Disposal Area Boundary
- Surface Soil
- Wetland
- Canal

HM - Heavy Metals
(#) - Number of heavy metals detected
Concentrations reported in mg/kg
* - Not all detected metals are shown

150 0 150
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 4-20. METALS DETECTED IN SURFACE SOIL - NORTHERN CONTAMINATED SOIL AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-20/Metals/SrfcSoil/ContSoilAreaNorth

Original includes color coding.

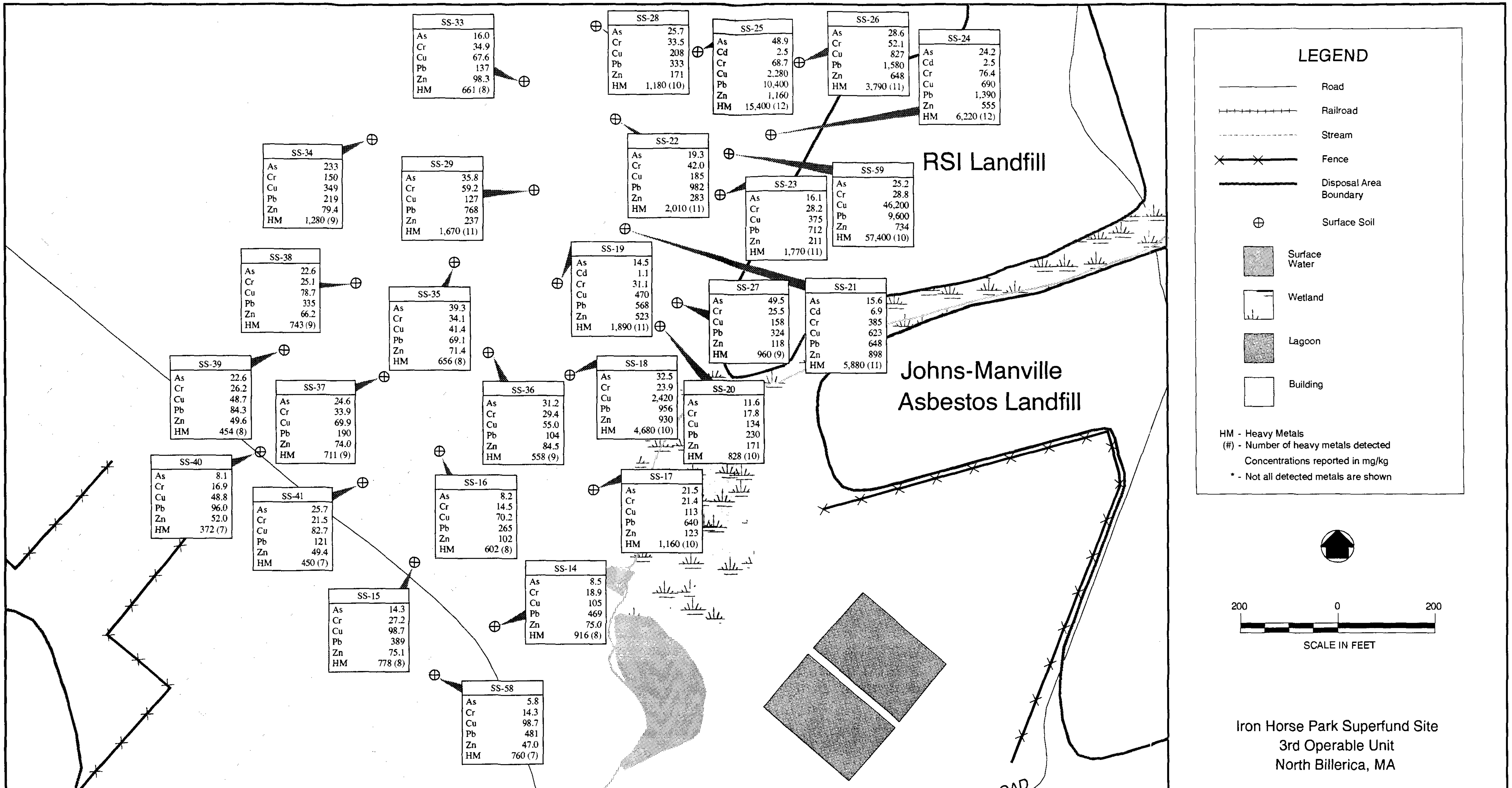


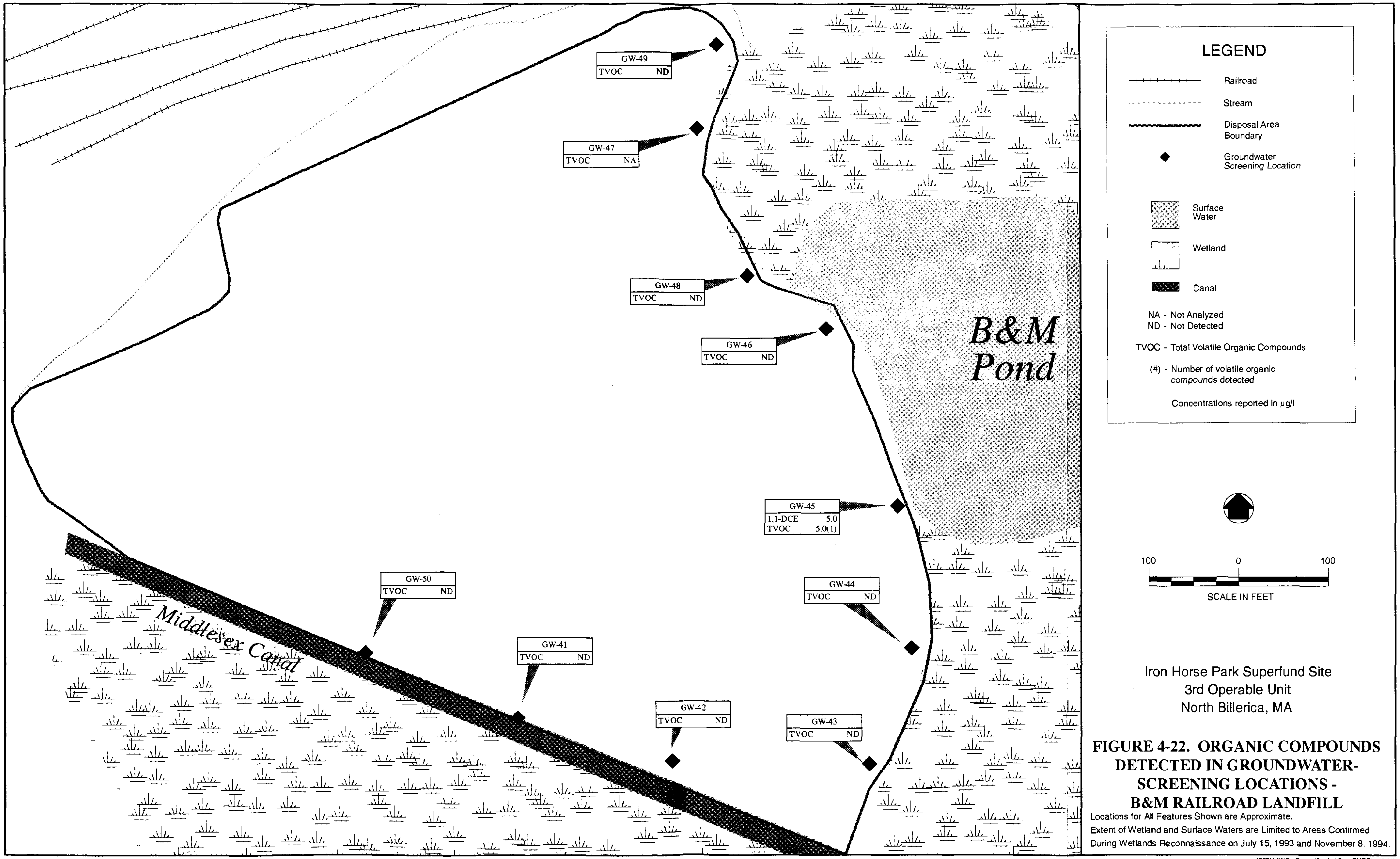
FIGURE 4-21. METALS DETECTED IN SURFACE SOIL - SOUTHERN CONTAMINATED SOIL AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-21/Metals/SrfcSoil/ContSoilAreaSouth

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

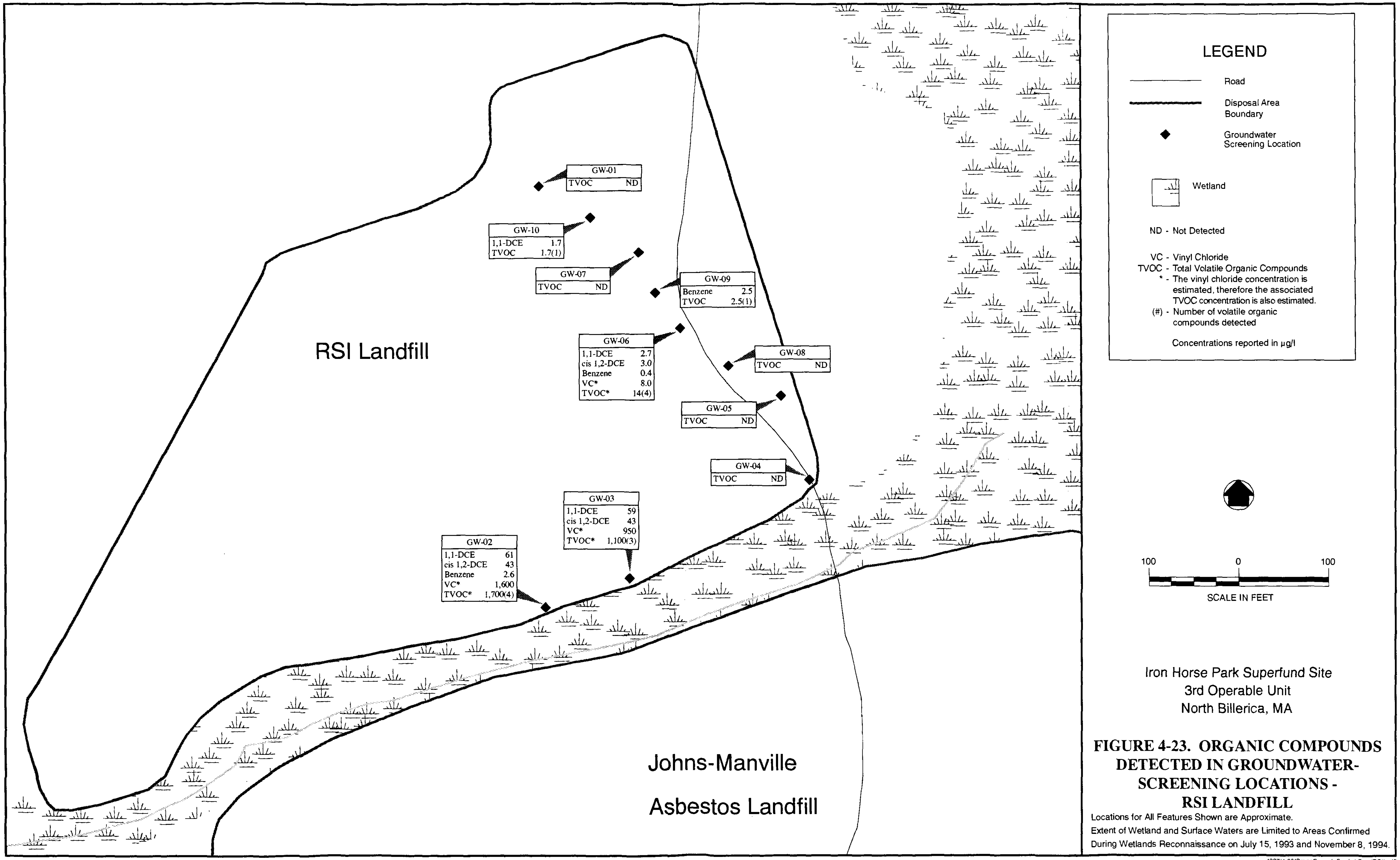
FIGURE 4-22. ORGANIC COMPOUNDS DETECTED IN GROUNDWATER-SCREENING LOCATIONS - B&M RAILROAD LANDFILL

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-22/OrgCmpndGrndwtrScrn/BMRRLndfl/GW

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

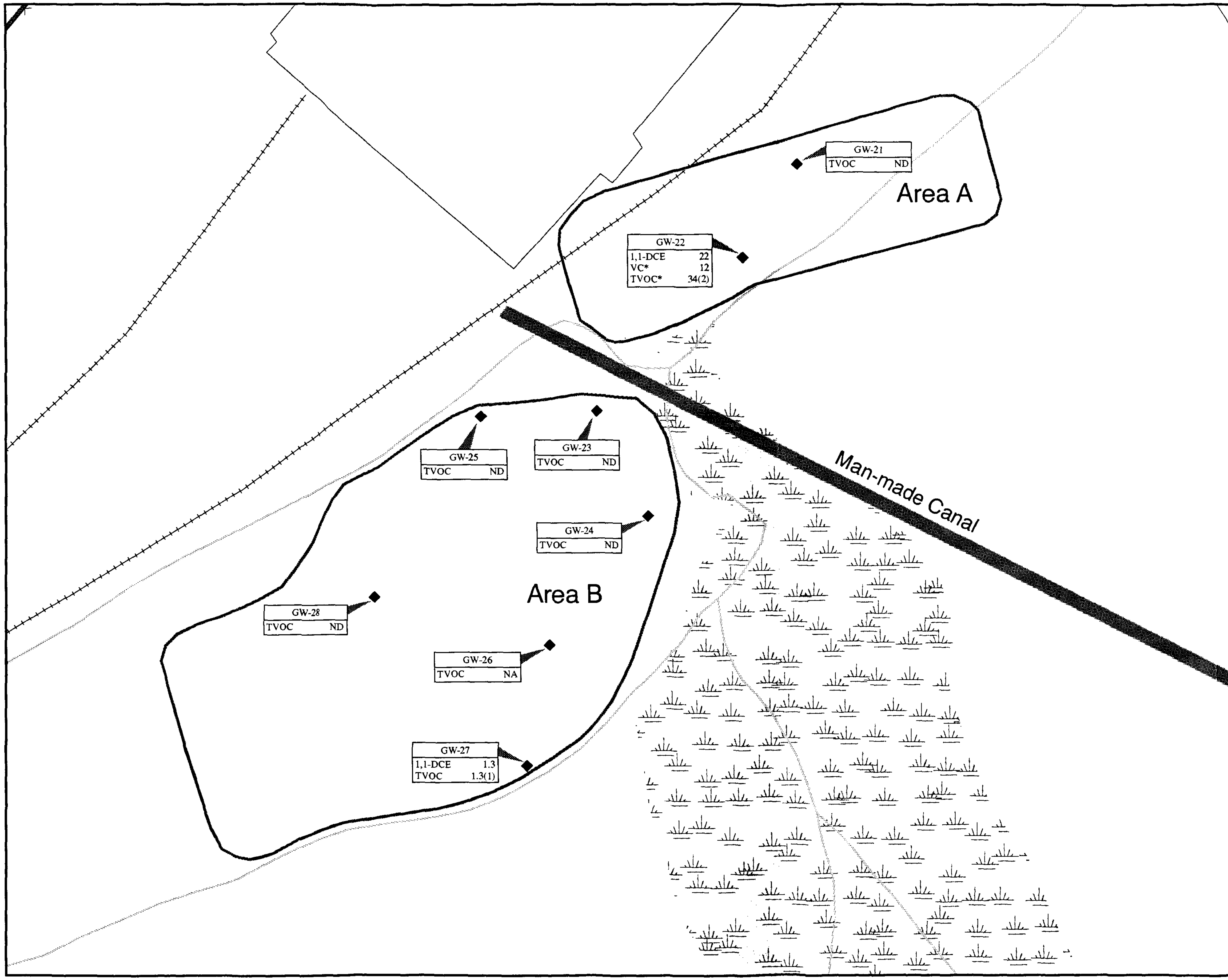
FIGURE 4-23. ORGANIC COMPOUNDS DETECTED IN GROUNDWATER-SCREENING LOCATIONS - RSI LANDFILL

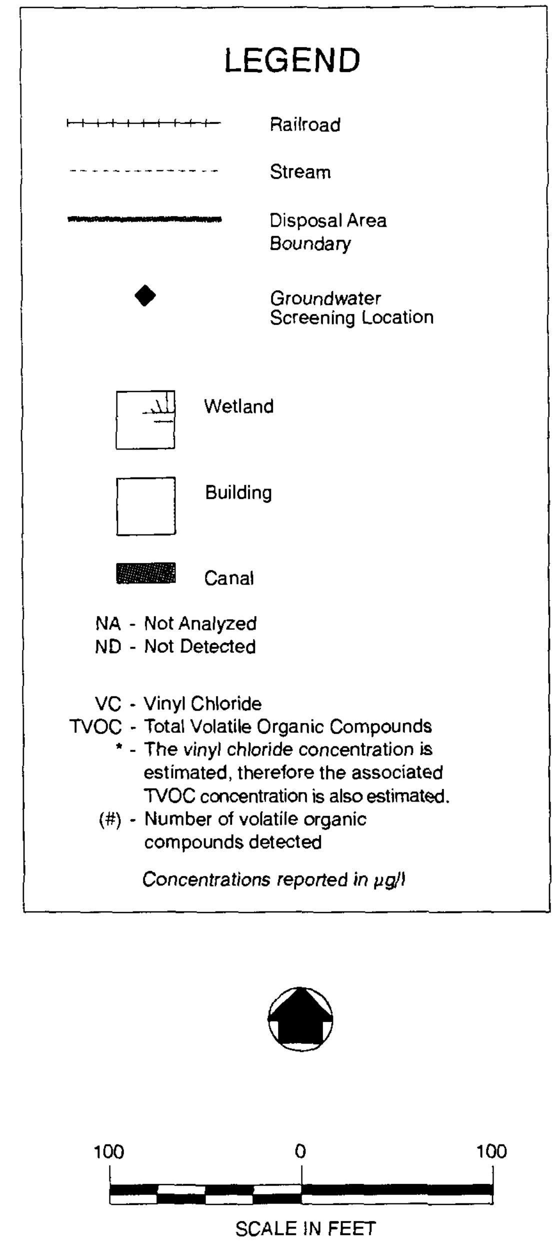
Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-23/OrgncCmpndsGrndwtrScrn/RSILndfl

Original includes color coding.

Metcalf & Eddy





Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

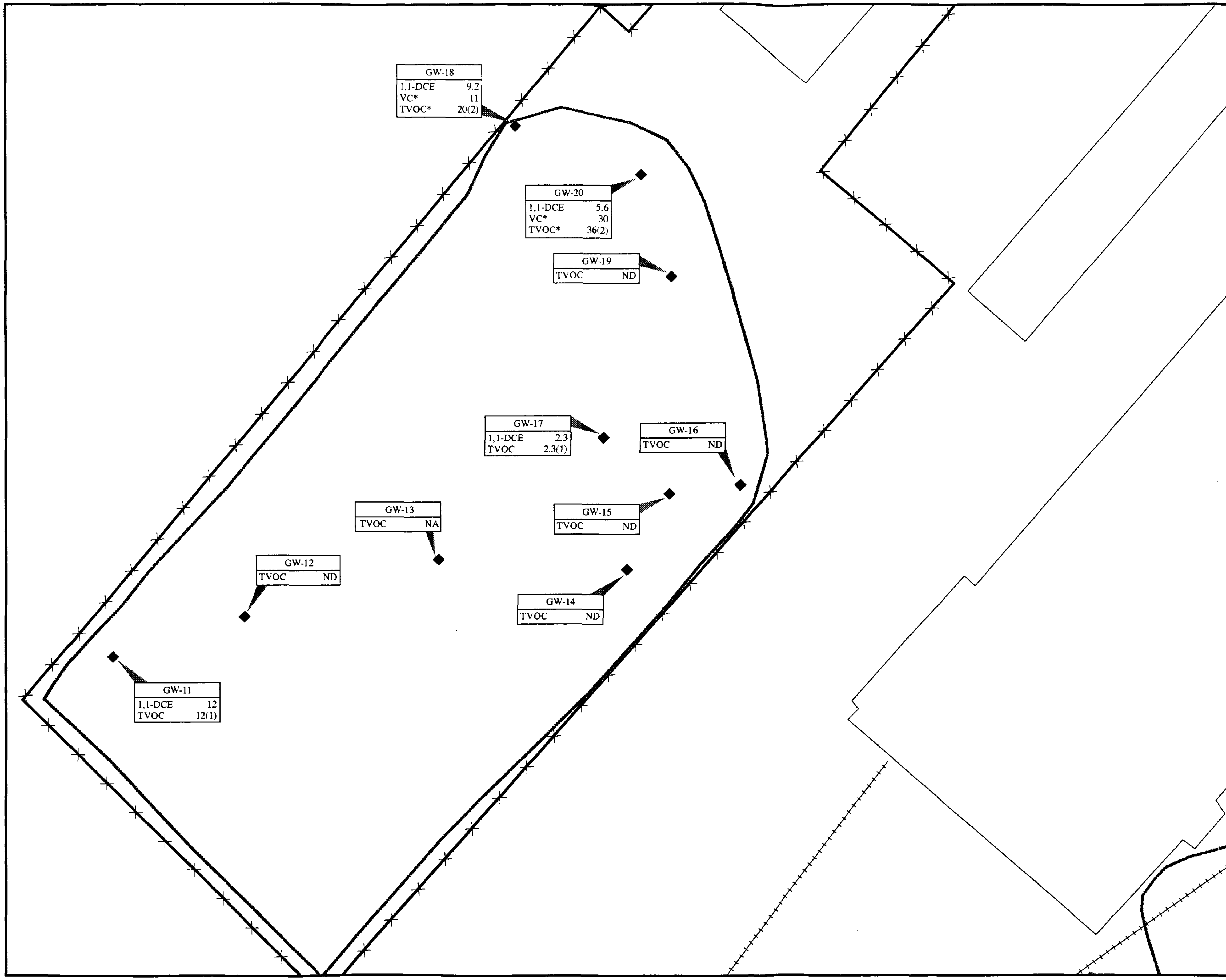
FIGURE 4-24. ORGANIC COMPOUNDS DETECTED IN GROUNDWATER-SCREENING LOCATIONS - B&M LOCOMOTIVE SHOP DISPOSAL AREAS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-24/OrgncCmpndsGrndwtrScrn/BMLocoShpDspsl

Original includes color coding.

Metcalf & Eddy



LEGEND

Railroad

Fence

Disposal Area Boundary

Groundwater Screening Location

Building

NA - Not Analyzed
ND - Not Detected

VC - Vinyl Chloride
TVOC - Total Volatile Organic Compounds
* - The vinyl chloride concentration is estimated, therefore the associated TVOC concentration is also estimated.
(#) - Number of volatile organic compounds detected

Concentrations reported in µg/l

100 0 100
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

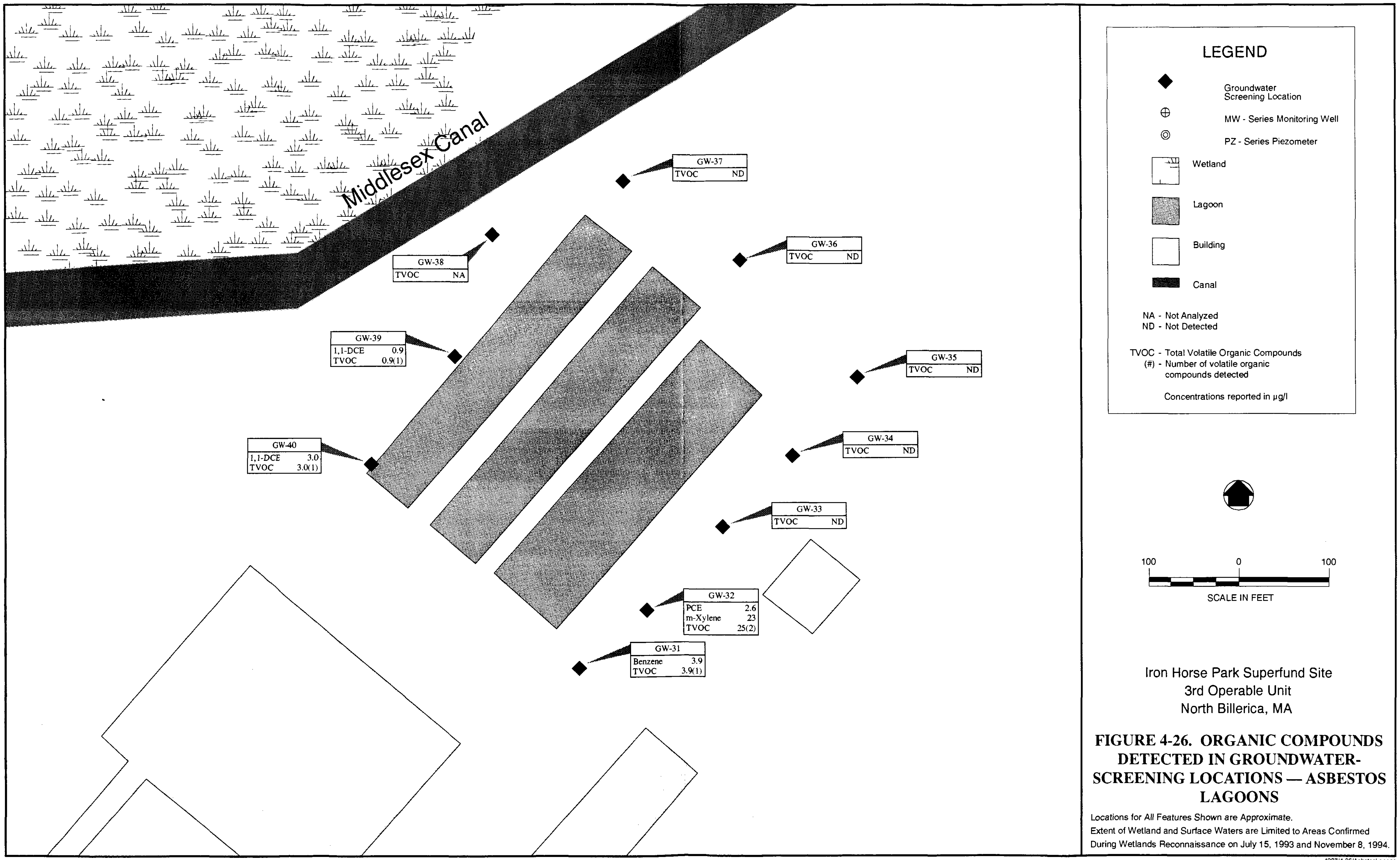
FIGURE 4-25. ORGANIC COMPOUNDS DETECTED IN GROUNDWATER-SCREENING LOCATIONS - OLD B&M OIL/SLUDGE RECYCLING AREA

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-25/OrgCmpndsGrndwtrScrn/BMOilSldgRcycl

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 4-26. ORGANIC COMPOUNDS DETECTED IN GROUNDWATER-SCREENING LOCATIONS — ASBESTOS LAGOONS

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-26/AsbstosLgoons

Original includes color coding.

Metcalf & Eddy

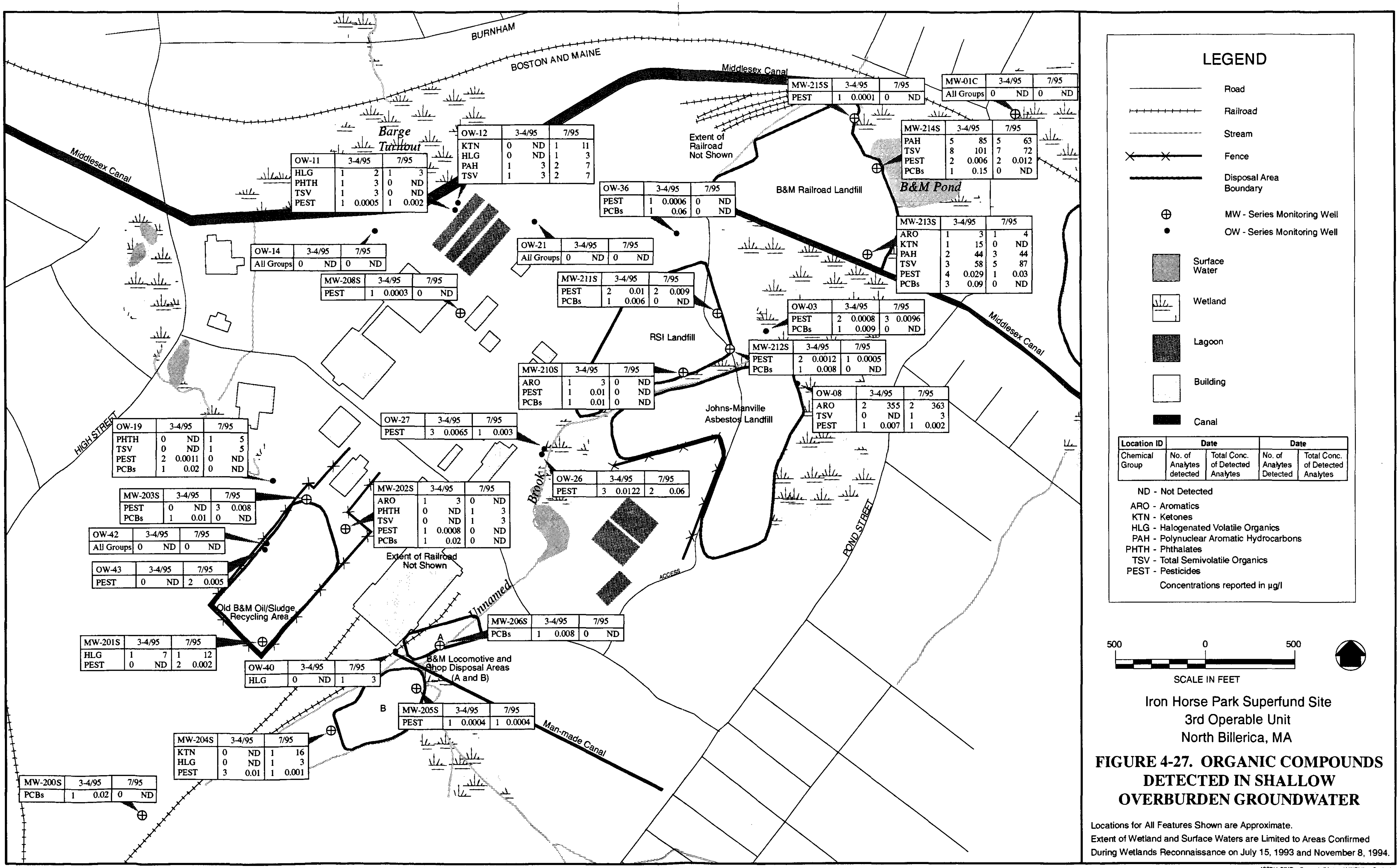
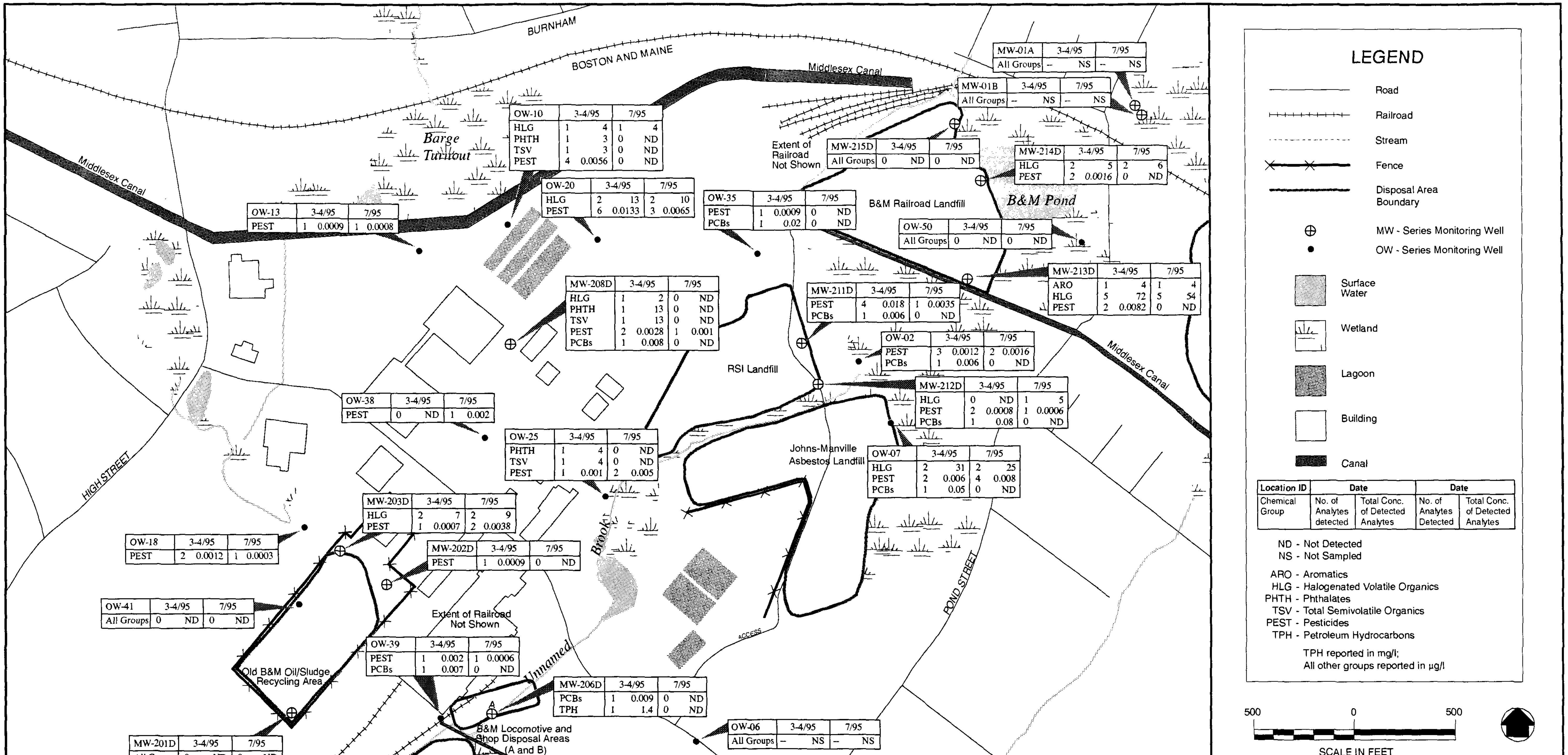


FIGURE 4-27. ORGANIC COMPOUNDS DETECTED IN SHALLOW OVERBURDEN GROUNDWATER

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

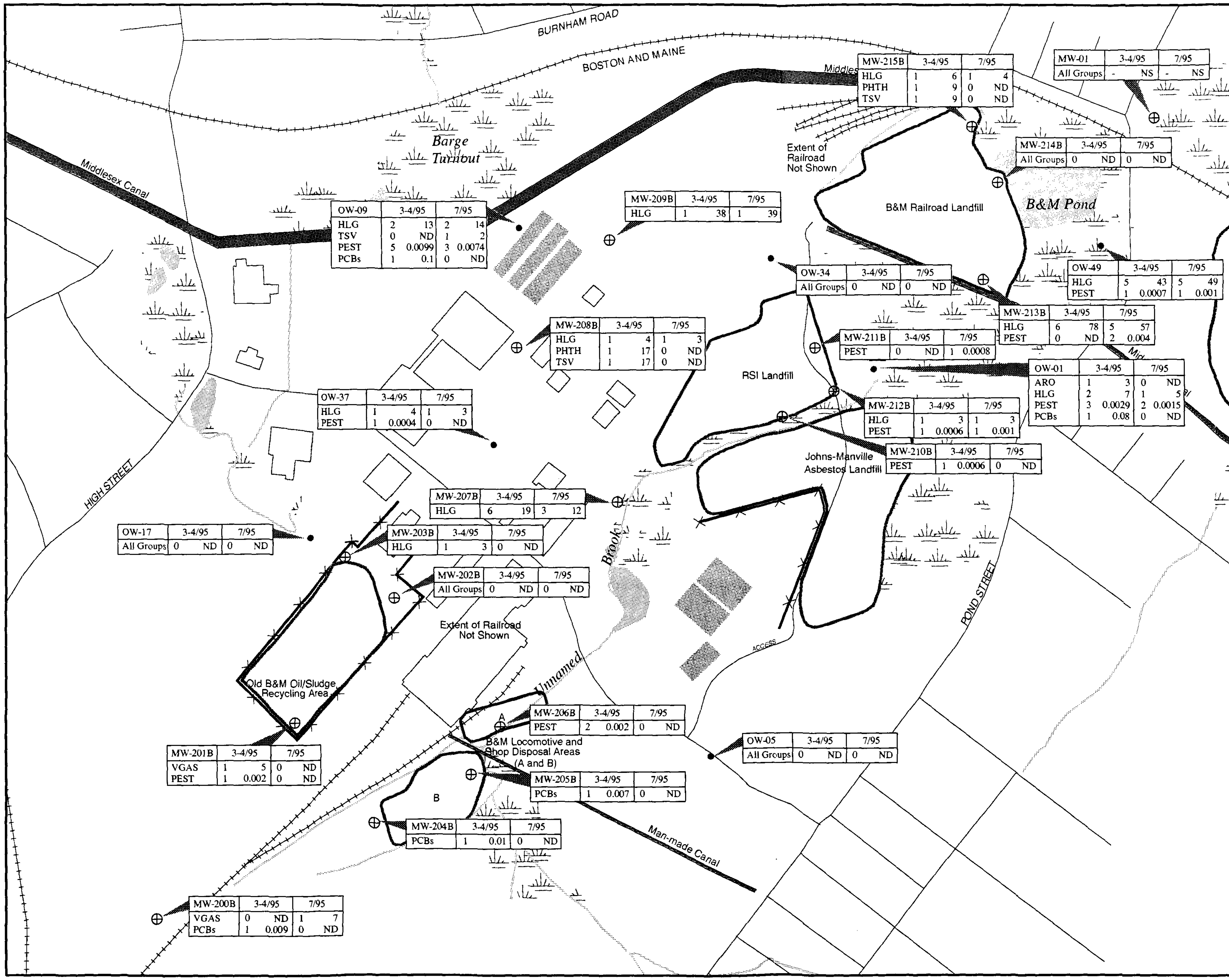
FIGURE 4-28. ORGANIC COMPOUNDS DETECTED IN DEEP OVERBURDEN GROUNDWATER

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-28/MntrngWll/DeepOvrbrdn/OrgCmpnds

Original includes color coding.

Metcalf & Eddy



Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

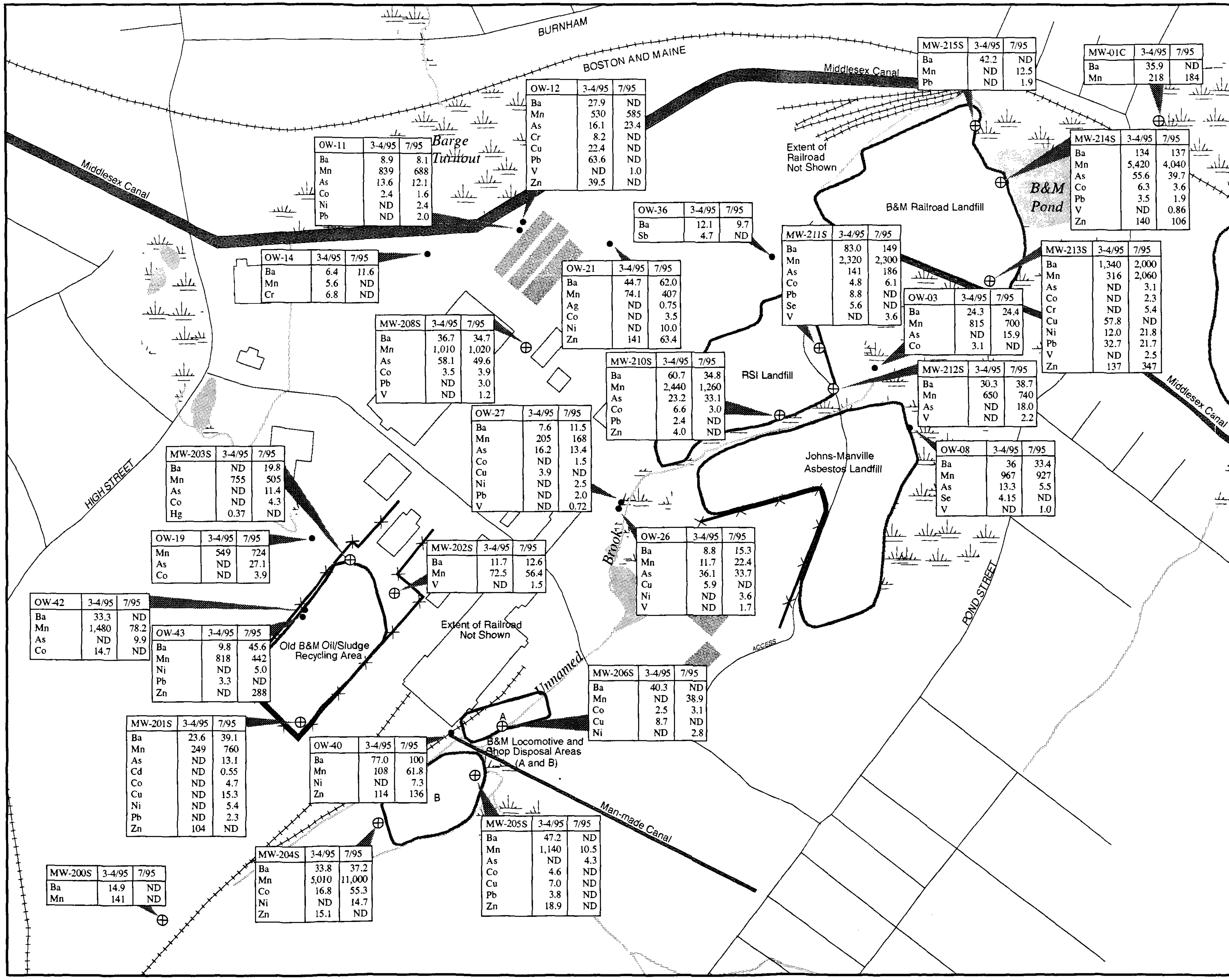
FIGURE 4-29. ORGANIC COMPOUNDS DETECTED IN BEDROCK GROUNDWATER

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-29/OrgCmpnds/MntrngWll/BdRock

Original includes color coding.

Metcalf & Eddy



OW-11	3-4/95	7/95
Ba	8.9	8.1
Mn	839	688
As	13.6	12.1
Co	2.4	1.6
Ni	ND	2.4
Pb	ND	2.0

OW-12	3-4/95	7/95
Ba	27.9	ND
Mn	530	585
As	16.1	23.4
Cr	8.2	ND
Cu	22.4	ND
Pb	63.6	ND
V	ND	1.0
Zn	39.5	ND

MW-215S	3-4/95	7/95
Ba	42.2	ND
Mn	ND	12.5
Pb	ND	1.9

MW-01C	3-4/95	7/95
Ba	35.9	ND
Mn	218	184

MW-214S	3-4/95	7/95
Ba	134	137
Mn	5,420	4,040
As	55.6	39.7
Co	6.3	3.6
Pb	3.5	1.9
V	ND	0.86
Zn	140	106

OW-36	3-4/95	7/95
Ba	12.1	9.7
Sb	4.7	ND

OW-14	3-4/95	7/95
Ba	6.4	11.6
Mn	5.6	ND
Cr	6.8	ND

OW-21	3-4/95	7/95
Ba	44.7	62.0
Mn	74.1	407
Ag	ND	0.75
Co	ND	3.5
Ni	ND	10.0
Zn	141	63.4

MW-211S	3-4/95	7/95
Ba	83.0	149
Mn	2,320	2,300
As	141	186
Co	4.8	6.1
Pb	8.8	ND
Se	5.6	ND
V	ND	3.6

MW-213S	3-4/95	7/95
Ba	1,340	2,000
Mn	316	2,060
As	ND	3.1
Co	ND	2.3
Cr	ND	5.4
Cu	57.8	ND
Ni	12.0	21.8
Pb	32.7	21.7
V	ND	2.5
Zn	137	347

OW-03	3-4/95	7/95
Ba	24.3	24.4
Mn	815	700
As	ND	15.9
Co	3.1	ND

MW-208S	3-4/95	7/95
Ba	36.7	34.7
Mn	1,010	1,020
As	58.1	49.6
Co	3.5	3.9
Pb	ND	3.0
V	ND	1.2

MW-210S	3-4/95	7/95
Ba	60.7	34.8
Mn	2,440	1,260
As	23.2	33.1
Co	6.6	3.0
Pb	2.4	ND
Zn	4.0	ND

MW-212S	3-4/95	7/95
Ba	30.3	38.7
Mn	650	740
As	ND	18.0
V	ND	2.2

OW-27	3-4/95	7/95
Ba	7.6	11.5
Mn	205	168
As	16.2	13.4
Co	ND	1.5
Cu	3.9	ND
Ni	ND	2.5
Pb	ND	2.0
V	ND	0.72

OW-08	3-4/95	7/95
Ba	36	33.4
Mn	967	927
As	13.3	5.5
Se	4.15	ND
V	ND	1.0

MW-203S	3-4/95	7/95
Ba	ND	19.8
Mn	755	505
As	ND	11.4
Co	ND	4.3
Hg	0.37	ND

OW-19	3-4/95	7/95
Mn	549	724
As	ND	27.1
Co	ND	3.9

MW-202S	3-4/95	7/95
Ba	11.7	12.6
Mn	72.5	56.4
V	ND	1.5

OW-26	3-4/95	7/95
Ba	8.8	15.3
Mn	11.7	22.4
As	36.1	33.7
Cu	5.9	ND
Ni	ND	3.6
V	ND	1.7

OW-42	3-4/95	7/95
Ba	33.3	ND
Mn	1,480	78.2
As	ND	9.9
Co	14.7	ND

OW-43	3-4/95	7/95
Ba	9.8	45.6
Mn	818	442
Ni	ND	5.0
Pb	3.3	ND
Zn	ND	288

MW-206S	3-4/95	7/95
Ba	40.3	ND
Mn	ND	38.9
Co	2.5	3.1
Cu	8.7	ND
Ni	ND	2.8

MW-201S	3-4/95	7/95
Ba	23.6	39.1
Mn	249	760
As	ND	13.1
Cd	ND	0.55
Co	ND	4.7
Cu	ND	15.3
Ni	ND	5.4
Pb	ND	2.3
Zn	104	ND

OW-40	3-4/95	7/95
Ba	77.0	100
Mn	108	61.8
Ni	ND	7.3
Zn	114	136

MW-205S	3-4/95	7/95
Ba	47.2	ND
Mn	1,140	10.5
As	ND	4.3
Co	4.6	ND
Cu	7.0	ND
Pb	3.8	ND
Zn	18.9	ND

MW-204S	3-4/95	7/95
Ba	33.8	37.2
Mn	5,010	11,000
Co	16.8	55.3
Ni	ND	14.7
Zn	15.1	ND

MW-200S	3-4/95	7/95
Ba	14.9	ND
Mn	141	ND

LEGEND

Road
Railroad
Stream
Fence
Disposal Area Boundary
MW - Series Monitoring Well
OW - Series Monitoring Well
Surface Water
Wetland
Lagoon
Building
Canal

ND - Not Detected
Concentrations reported in µg/l
* - Major metal ions not shown

500 0 500
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

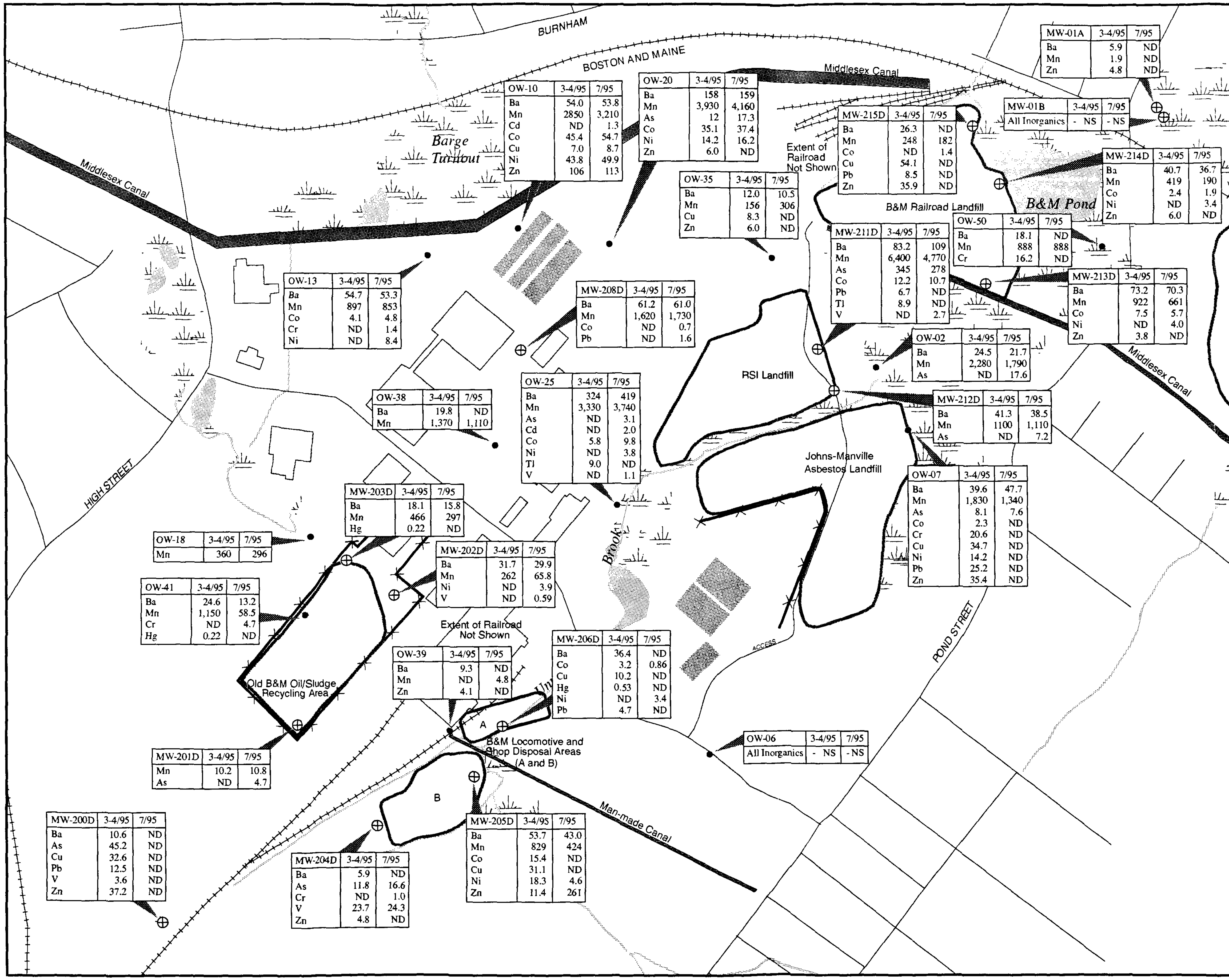
FIGURE 4-30. METALS DETECTED IN SHALLOW OVERBURDEN GROUNDWATER

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-30/MontrngWll/ShllowOvrbrdn/Metals

Original includes color coding.

Metcalf & Eddy



MW-01A	3-4/95	7/95
Ba	5.9	ND
Mn	1.9	ND
Zn	4.8	ND

OW-10	3-4/95	7/95
Ba	54.0	53.8
Mn	2850	3,210
Cd	ND	1.3
Co	45.4	54.7
Cu	7.0	8.7
Ni	43.8	49.9
Zn	106	113

OW-20	3-4/95	7/95
Ba	158	159
Mn	3,930	4,160
As	12	17.3
Co	35.1	37.4
Ni	14.2	16.2
Zn	6.0	ND

MW-01B	3-4/95	7/95
All Inorganics	- NS	- NS

MW-215D	3-4/95	7/95
Ba	26.3	ND
Mn	248	182
Co	ND	1.4
Cu	54.1	ND
Pb	8.5	ND
Zn	35.9	ND

OW-35	3-4/95	7/95
Ba	12.0	10.5
Mn	156	306
Cu	8.3	ND
Zn	6.0	ND

MW-214D	3-4/95	7/95
Ba	40.7	36.7
Mn	419	190
Co	2.4	1.9
Ni	ND	3.4
Zn	6.0	ND

OW-50	3-4/95	7/95
Ba	18.1	ND
Mn	888	888
Cr	16.2	ND

MW-211D	3-4/95	7/95
Ba	83.2	109
Mn	6,400	4,770
As	345	278
Co	12.2	10.7
Pb	6.7	ND
Tl	8.9	ND
V	ND	2.7

OW-13	3-4/95	7/95
Ba	54.7	53.3
Mn	897	853
Co	4.1	4.8
Cr	ND	1.4
Ni	ND	8.4

MW-213D	3-4/95	7/95
Ba	73.2	70.3
Mn	922	661
Co	7.5	5.7
Ni	ND	4.0
Zn	3.8	ND

MW-208D	3-4/95	7/95
Ba	61.2	61.0
Mn	1,620	1,730
Co	ND	0.7
Pb	ND	1.6

OW-02	3-4/95	7/95
Ba	24.5	21.7
Mn	2,280	1,790
As	ND	17.6

OW-25	3-4/95	7/95
Ba	324	419
Mn	3,330	3,740
As	ND	3.1
Cd	ND	2.0
Co	5.8	9.8
Ni	ND	3.8
Tl	9.0	ND
V	ND	1.1

OW-38	3-4/95	7/95
Ba	19.8	ND
Mn	1,370	1,110

MW-212D	3-4/95	7/95
Ba	41.3	38.5
Mn	1100	1,110
As	ND	7.2

OW-07	3-4/95	7/95
Ba	39.6	47.7
Mn	1,830	1,340
As	8.1	7.6
Co	2.3	ND
Cr	20.6	ND
Cu	34.7	ND
Ni	14.2	ND
Pb	25.2	ND
Zn	35.4	ND

MW-203D	3-4/95	7/95
Ba	18.1	15.8
Mn	466	297
Hg	0.22	ND

OW-18	3-4/95	7/95
Mn	360	296

MW-202D	3-4/95	7/95
Ba	31.7	29.9
Mn	262	65.8
Ni	ND	3.9
V	ND	0.59

OW-41	3-4/95	7/95
Ba	24.6	13.2
Mn	1,150	58.5
Cr	ND	4.7
Hg	0.22	ND

MW-206D	3-4/95	7/95
Ba	36.4	ND
Co	3.2	0.86
Cu	10.2	ND
Hg	0.53	ND
Ni	ND	3.4
Pb	4.7	ND

OW-39	3-4/95	7/95
Ba	9.3	ND
Mn	ND	4.8
Zn	4.1	ND

OW-06	3-4/95	7/95
All Inorganics	- NS	- NS

MW-201D	3-4/95	7/95
Mn	10.2	10.8
As	ND	4.7

MW-200D	3-4/95	7/95
Ba	10.6	ND
As	45.2	ND
Cu	32.6	ND
Pb	12.5	ND
V	3.6	ND
Zn	37.2	ND

MW-205D	3-4/95	7/95
Ba	53.7	43.0
Mn	829	424
Co	15.4	ND
Cu	31.1	ND
Ni	18.3	4.6
Zn	11.4	261

MW-204D	3-4/95	7/95
Ba	5.9	ND
As	11.8	16.6
Cr	ND	1.0
V	23.7	24.3
Zn	4.8	ND

LEGEND

Road
Railroad
Stream
Fence
Disposal Area Boundary
MW - Series Monitoring Well
OW - Series Monitoring Well
Surface Water
Wetland
Lagoon
Building
Canal

ND - Not Detected
NS - Not Sampled

Concentrations reported in µg/l
* - Major metal ions not shown

500 0 500
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

FIGURE 4-31. METALS DETECTED IN DEEP OVERBURDEN GROUNDWATER

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-31/MntrngWl/DeepOvrbrdn/Metals

Original includes color coding.

Metcalf & Eddy

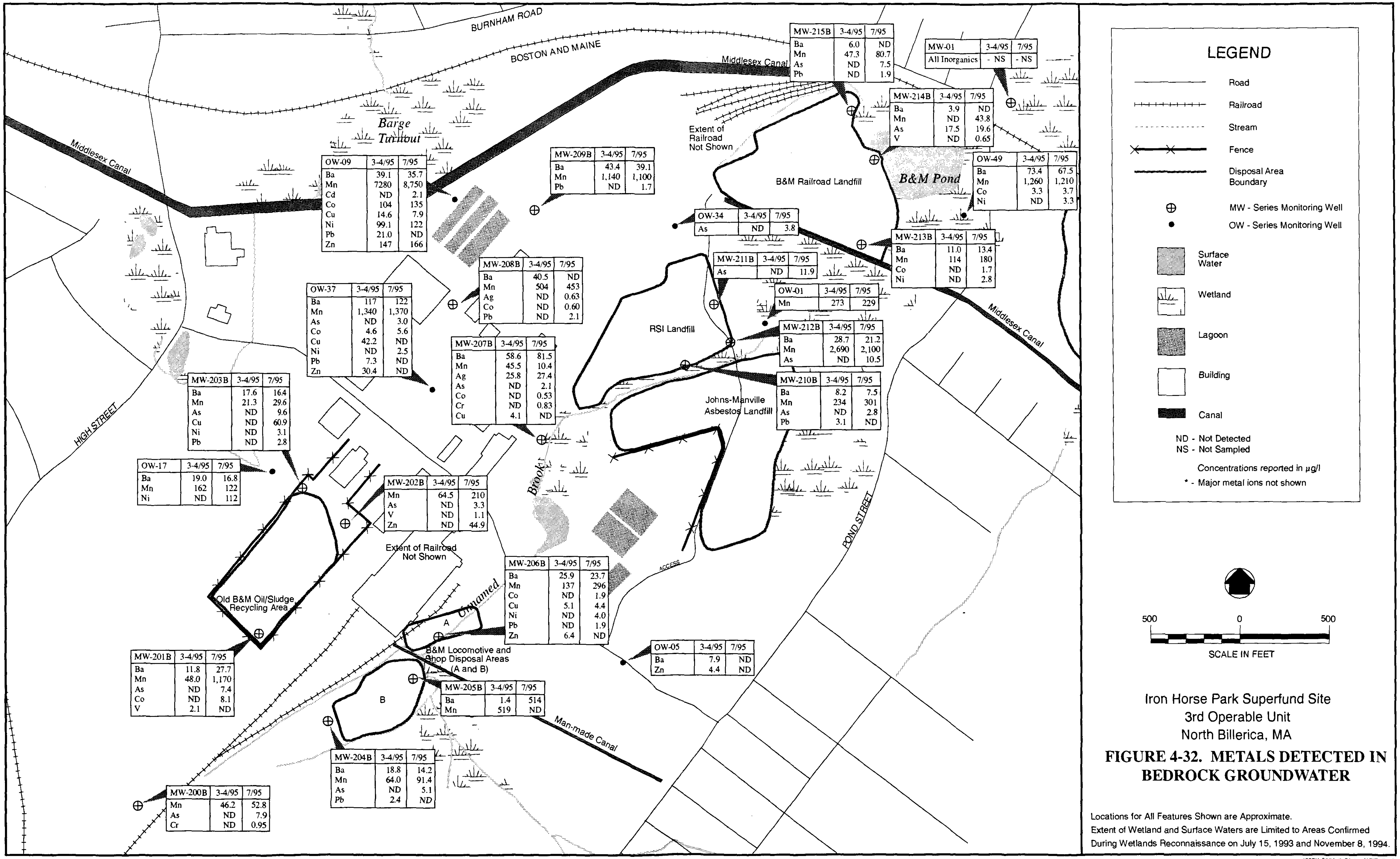


FIGURE 4-32. METALS DETECTED IN BEDROCK GROUNDWATER

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-32/Metls/MntrngWll/BdRock

Original includes color coding.

Metcalf & Eddy

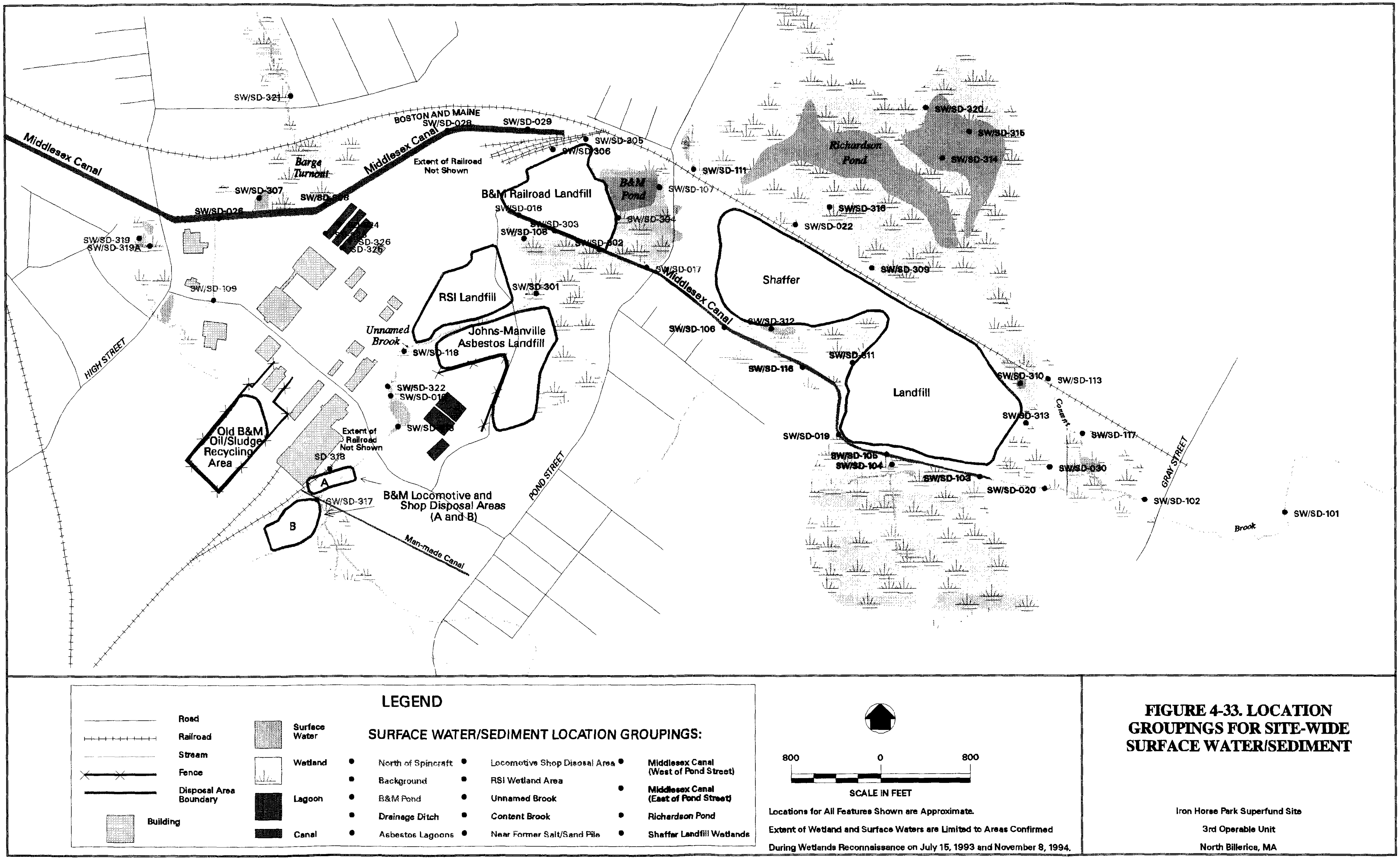


FIGURE 4-33. LOCATION GROUPINGS FOR SITE-WIDE SURFACE WATER/SEDIMENT

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3rd Operable Unit
North Billerica, MA

swedzones.aml July 1996

Original includes color coding.

Metcalf & Eddy

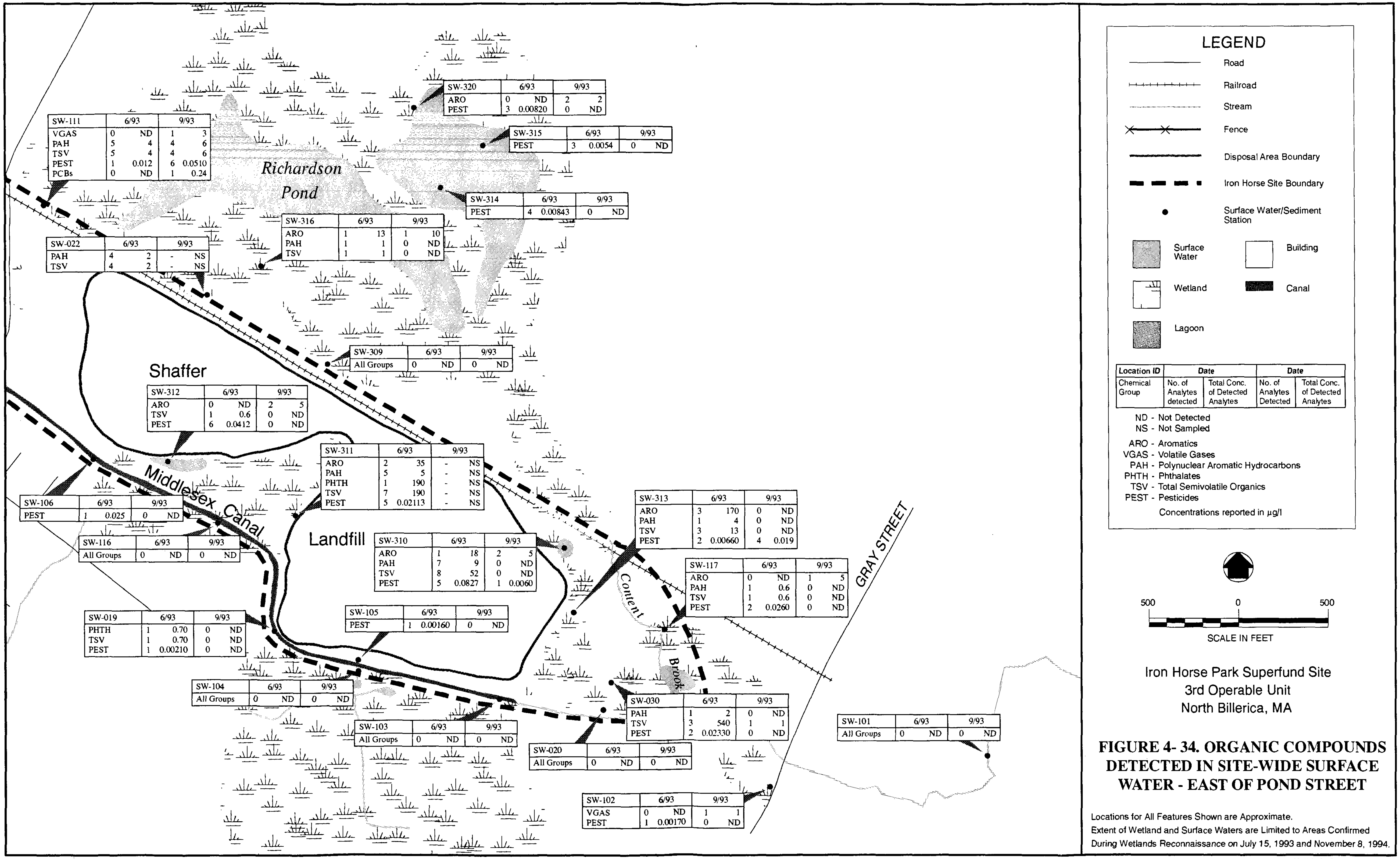


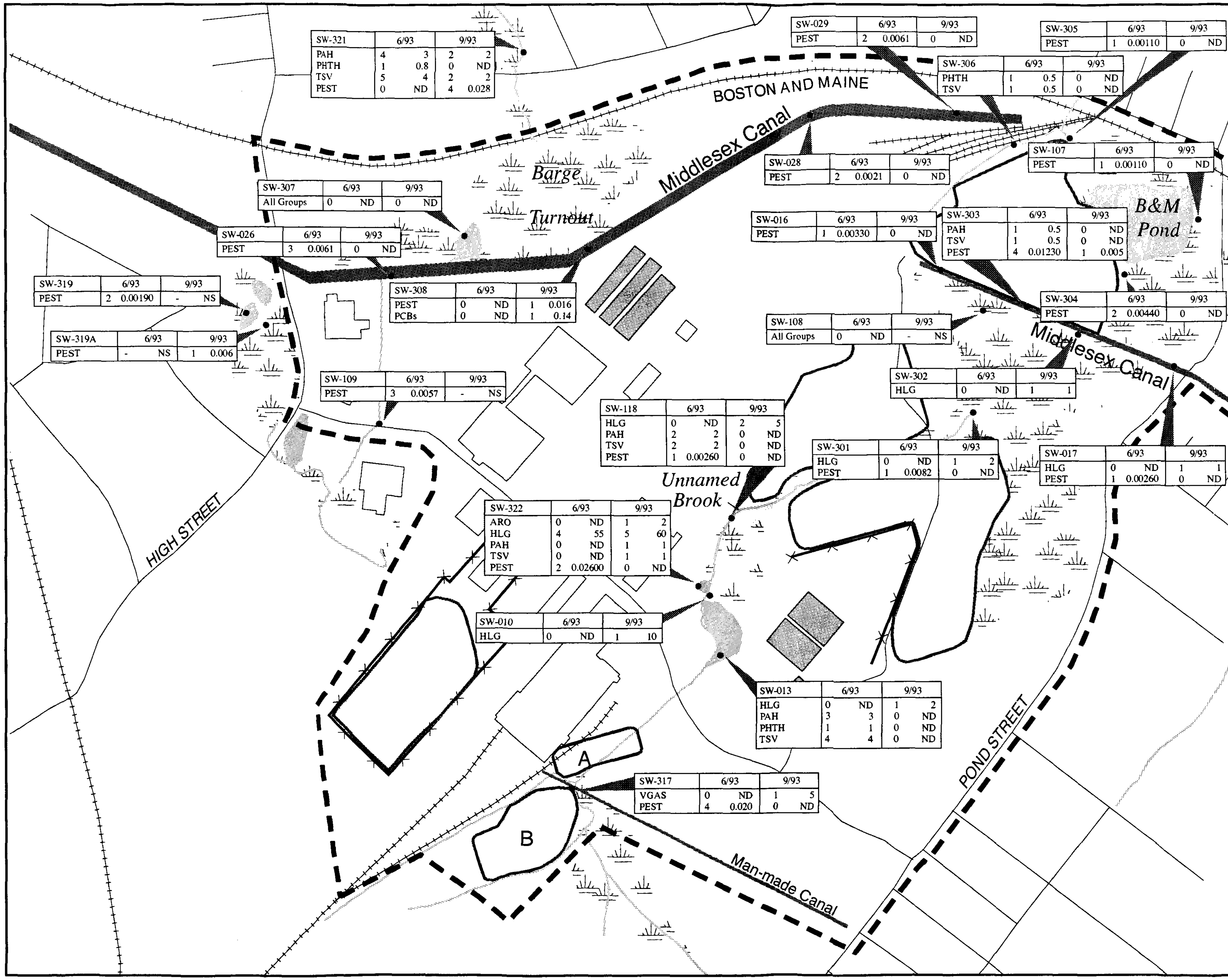
FIGURE 4- 34. ORGANIC COMPOUNDS DETECTED IN SITE-WIDE SURFACE WATER - EAST OF POND STREET

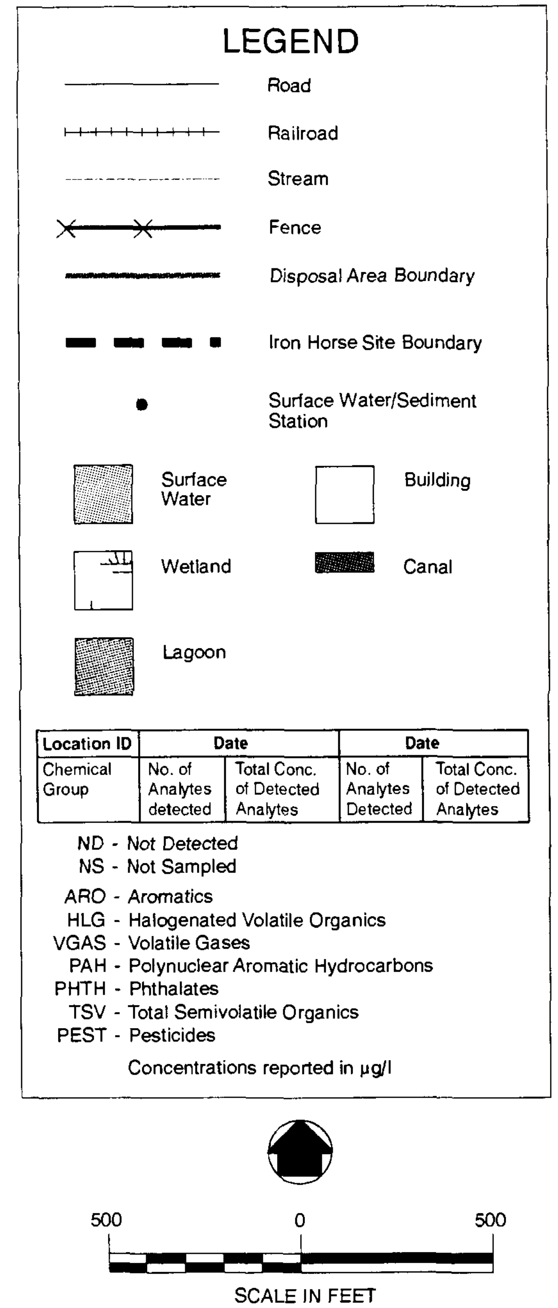
Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-34/OrgCmpnd/SrfcWtr/EPndSt

Original includes color coding.

Metcalf & Eddy





Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

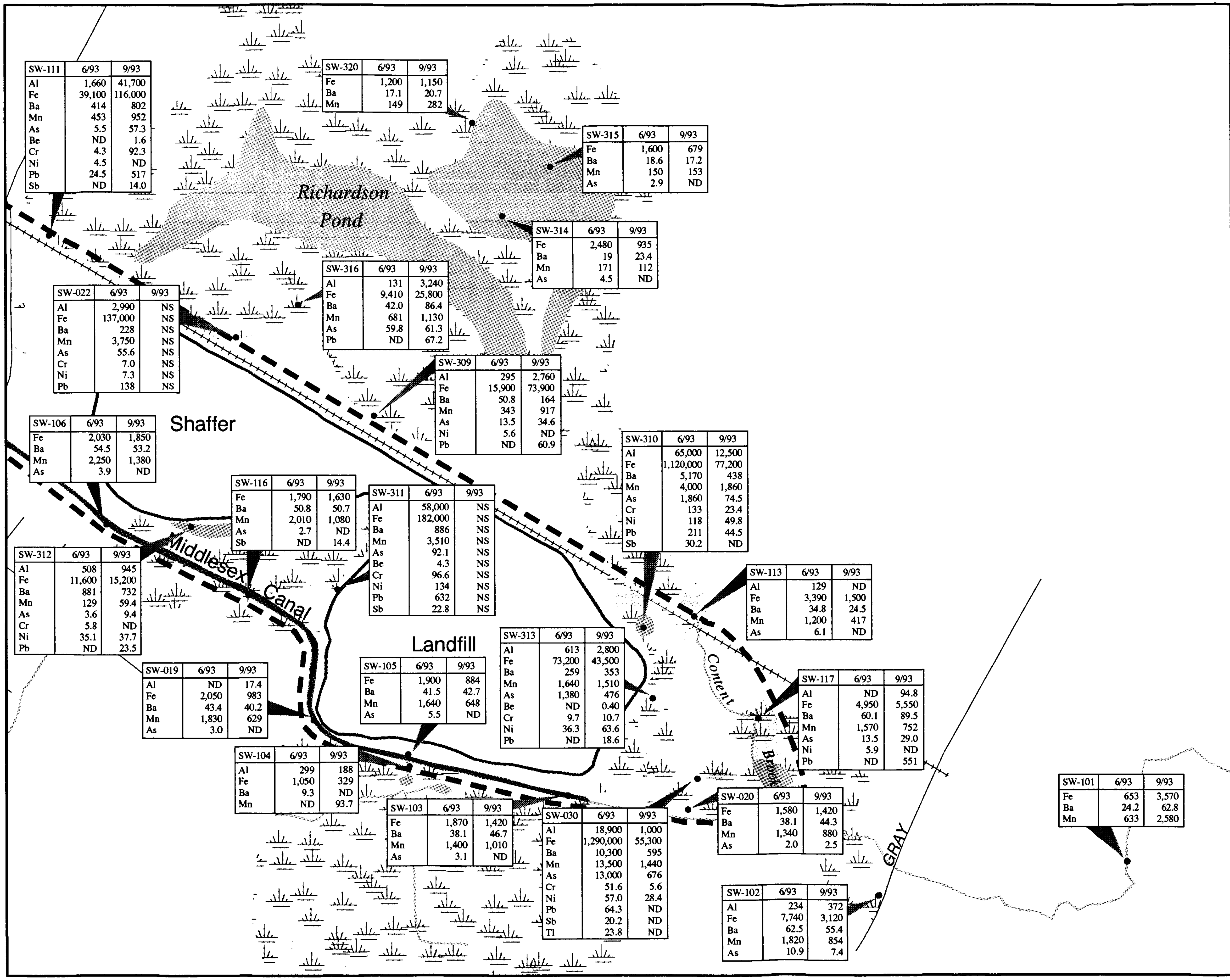
FIGURE 4-35. ORGANIC COMPOUNDS DETECTED IN SITE-WIDE SURFACE WATER - WEST OF POND STREET

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-35/OrgCmpnd/SrfcWtr/WstPndSt

Original includes color coding.

Metcalf & Eddy



SW-111	6/93	9/93
Al	1,660	41,700
Fe	39,100	116,000
Ba	414	802
Mn	453	952
As	5.5	57.3
Be	ND	1.6
Cr	4.3	92.3
Ni	4.5	ND
Pb	24.5	517
Sb	ND	14.0

SW-320	6/93	9/93
Fe	1,200	1,150
Ba	17.1	20.7
Mn	149	282

SW-315	6/93	9/93
Fe	1,600	679
Ba	18.6	17.2
Mn	150	153
As	2.9	ND

SW-314	6/93	9/93
Fe	2,480	935
Ba	19	23.4
Mn	171	112
As	4.5	ND

SW-316	6/93	9/93
Al	131	3,240
Fe	9,410	25,800
Ba	42.0	86.4
Mn	681	1,130
As	59.8	61.3
Pb	ND	67.2

SW-022	6/93	9/93
Al	2,990	NS
Fe	137,000	NS
Ba	228	NS
Mn	3,750	NS
As	55.6	NS
Cr	7.0	NS
Ni	7.3	NS
Pb	138	NS

SW-309	6/93	9/93
Al	295	2,760
Fe	15,900	73,900
Ba	50.8	164
Mn	343	917
As	13.5	34.6
Ni	5.6	ND
Pb	ND	60.9

SW-106	6/93	9/93
Fe	2,030	1,850
Ba	54.5	53.2
Mn	2,250	1,380
As	3.9	ND

SW-310	6/93	9/93
Al	65,000	12,500
Fe	1,120,000	77,200
Ba	5,170	438
Mn	4,000	1,860
As	1,860	74.5
Cr	133	23.4
Ni	118	49.8
Pb	211	44.5
Sb	30.2	ND

SW-116	6/93	9/93
Fe	1,790	1,630
Ba	50.8	50.7
Mn	2,010	1,080
As	2.7	ND
Sb	ND	14.4

SW-311	6/93	9/93
Al	58,000	NS
Fe	182,000	NS
Ba	886	NS
Mn	3,510	NS
As	92.1	NS
Be	4.3	NS
Cr	96.6	NS
Ni	134	NS
Pb	632	NS
Sb	22.8	NS

SW-312	6/93	9/93
Al	508	945
Fe	11,600	15,200
Ba	881	732
Mn	129	59.4
As	3.6	9.4
Cr	5.8	ND
Ni	35.1	37.7
Pb	ND	23.5

SW-113	6/93	9/93
Al	129	ND
Fe	3,390	1,500
Ba	34.8	24.5
Mn	1,200	417
As	6.1	ND

SW-313	6/93	9/93
Al	613	2,800
Fe	73,200	43,500
Ba	259	353
Mn	1,640	1,510
As	1,380	476
Be	ND	0.40
Cr	9.7	10.7
Ni	36.3	63.6
Pb	ND	18.6

SW-019	6/93	9/93
Al	ND	17.4
Fe	2,050	983
Ba	43.4	40.2
Mn	1,830	629
As	3.0	ND

SW-105	6/93	9/93
Fe	1,900	884
Ba	41.5	42.7
Mn	1,640	648
As	5.5	ND

SW-117	6/93	9/93
Al	ND	94.8
Fe	4,950	5,550
Ba	60.1	89.5
Mn	1,570	752
As	13.5	29.0
Ni	5.9	ND
Pb	ND	551

SW-104	6/93	9/93
Al	299	188
Fe	1,050	329
Ba	9.3	ND
Mn	ND	93.7

SW-101	6/93	9/93
Fe	653	3,570
Ba	24.2	62.8
Mn	633	2,580

SW-020	6/93	9/93
Fe	1,580	1,420
Ba	38.1	44.3
Mn	1,340	880
As	2.0	2.5

SW-103	6/93	9/93
Fe	1,870	1,420
Ba	38.1	46.7
Mn	1,400	1,010
As	3.1	ND

SW-030	6/93	9/93
Al	18,900	1,000
Fe	1,290,000	55,300
Ba	10,300	595
Mn	13,500	1,440
As	13,000	676
Cr	51.6	5.6
Ni	57.0	28.4
Pb	64.3	ND
Sb	20.2	ND
Tl	23.8	ND

SW-102	6/93	9/93
Al	234	372
Fe	7,740	3,120
Ba	62.5	55.4
Mn	1,820	854
As	10.9	7.4

LEGEND

Road
Railroad
Stream
Fence
Disposal Area Boundary
Iron Horse Site Boundary
Surface Water/ Sediment Station
Surface Water
Wetland
Lagoon
Building
Canal

ND - Not Detected
NS - Not Sampled
Concentrations reported in µg/l
* - Not all detected metals are shown

500 0 500
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

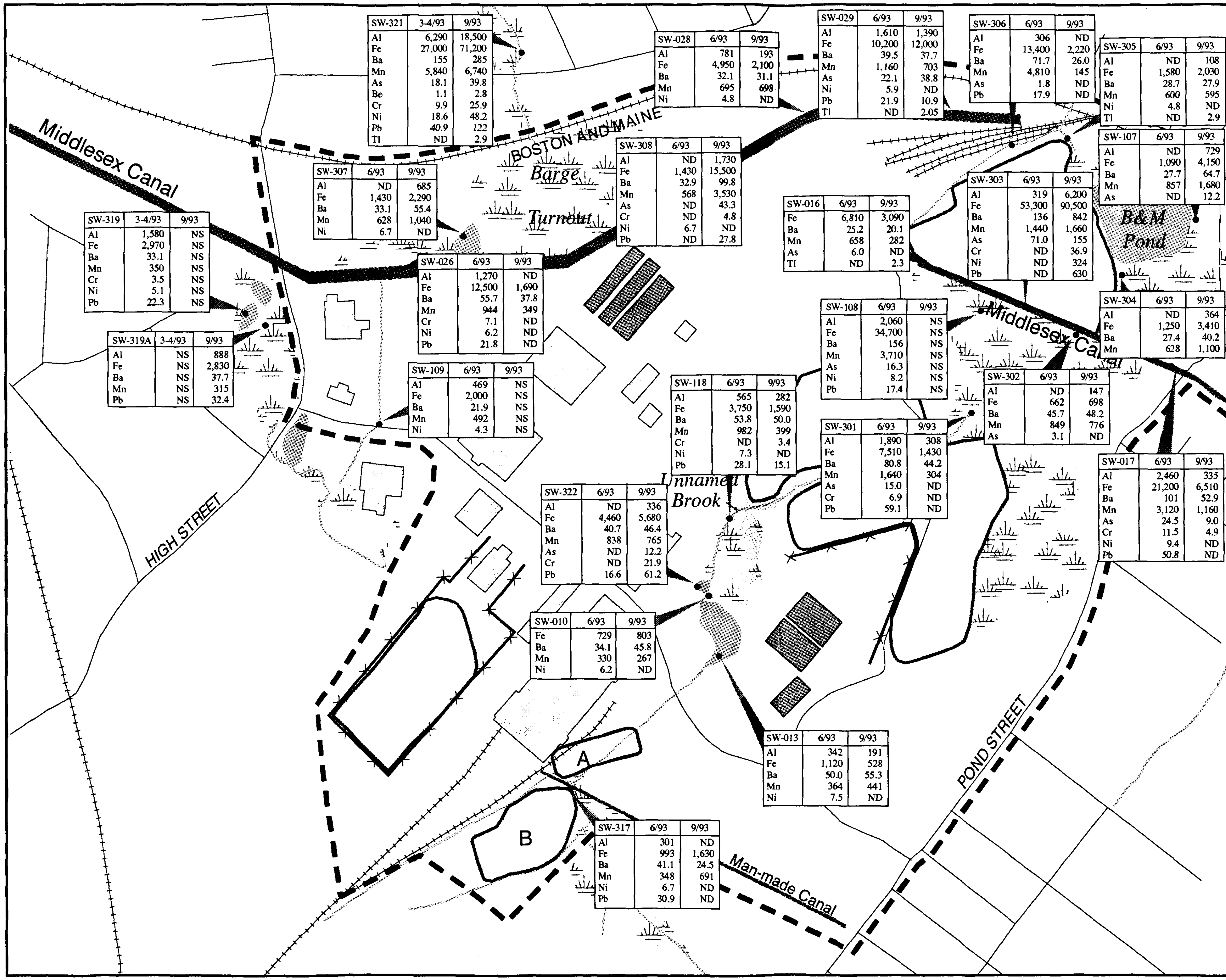
FIGURE 4-36. METALS DETECTED IN SITE-WIDE SURFACE WATER - EAST OF POND STREET

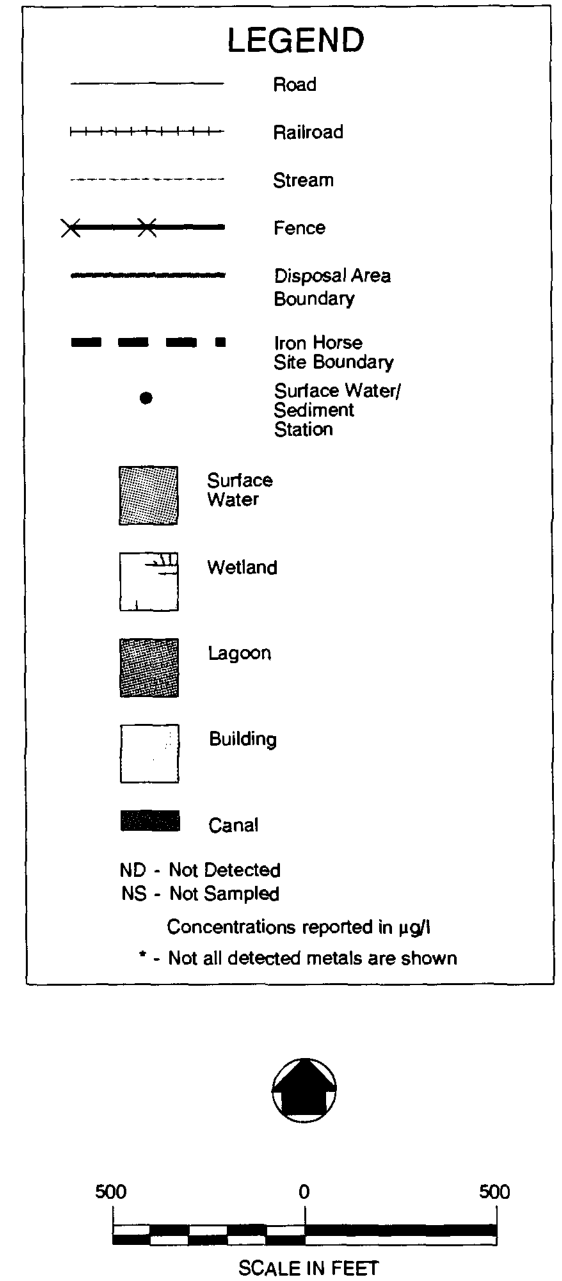
Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-36/Metals/SrfcWtr/EPndSt

Original includes color coding.

Metcalf & Eddy





Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

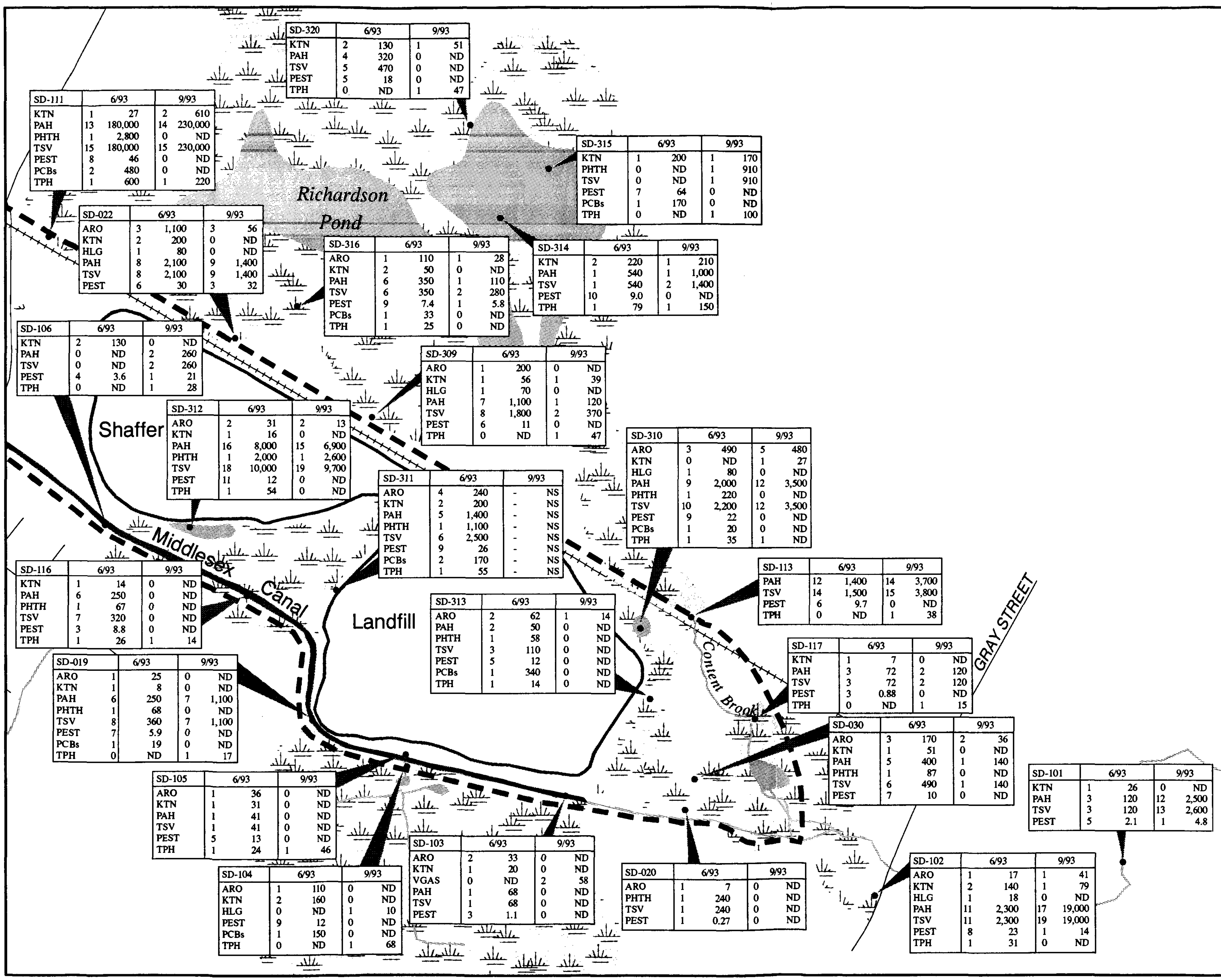
FIGURE 4-37. METALS DETECTED IN SITE-WIDE SURFACE WATER - WEST OF POND STREET

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-37/Metals/SrfcWtr/WstPndSt

Original includes color coding.

Metcalf & Eddy



SD-320	6/93		9/93	
KTN	2	130	1	51
PAH	4	320	0	ND
TSV	5	470	0	ND
PEST	5	18	0	ND
TPH	0	ND	1	47

SD-111	6/93		9/93	
KTN	1	27	2	610
PAH	13	180,000	14	230,000
PHTH	1	2,800	0	ND
TSV	15	180,000	15	230,000
PEST	8	46	0	ND
PCBs	2	480	0	ND
TPH	1	600	1	220

SD-315	6/93		9/93	
KTN	1	200	1	170
PHTH	0	ND	1	910
TSV	0	ND	1	910
PEST	7	64	0	ND
PCBs	1	170	0	ND
TPH	0	ND	1	100

SD-022	6/93		9/93	
ARO	3	1,100	3	56
KTN	2	200	0	ND
HLG	1	80	0	ND
PAH	8	2,100	9	1,400
TSV	8	2,100	9	1,400
PEST	6	30	3	32

SD-316	6/93		9/93	
ARO	1	110	1	28
KTN	2	50	0	ND
PAH	6	350	1	110
TSV	6	350	2	280
PEST	9	7.4	1	5.8
PCBs	1	33	0	ND
TPH	1	25	0	ND

SD-314	6/93		9/93	
KTN	2	220	1	210
PAH	1	540	1	1,000
TSV	1	540	2	1,400
PEST	10	9.0	0	ND
TPH	1	79	1	150

SD-106	6/93		9/93	
KTN	2	130	0	ND
PAH	0	ND	2	260
TSV	0	ND	2	260
PEST	4	3.6	1	21
TPH	0	ND	1	28

SD-309	6/93		9/93	
ARO	1	200	0	ND
KTN	1	56	1	39
HLG	1	70	0	ND
PAH	7	1,100	1	120
TSV	8	1,800	2	370
PEST	6	11	0	ND
TPH	0	ND	1	47

SD-312	6/93		9/93	
ARO	2	31	2	13
KTN	1	16	0	ND
PAH	16	8,000	15	6,900
PHTH	1	2,000	1	2,600
TSV	18	10,000	19	9,700
PEST	11	12	0	ND
TPH	1	54	0	ND

SD-310	6/93		9/93	
ARO	3	490	5	480
KTN	0	ND	1	27
HLG	1	80	0	ND
PAH	9	2,000	12	3,500
PHTH	1	220	0	ND
TSV	10	2,200	12	3,500
PEST	9	22	0	ND
PCBs	1	20	0	ND
TPH	1	35	1	ND

SD-311	6/93		9/93	
ARO	4	240	-	NS
KTN	2	200	-	NS
PAH	5	1,400	-	NS
PHTH	1	1,100	-	NS
TSV	6	2,500	-	NS
PEST	9	26	-	NS
PCBs	2	170	-	NS
TPH	1	55	-	NS

SD-116	6/93		9/93	
KTN	1	14	0	ND
PAH	6	250	0	ND
PHTH	1	67	0	ND
TSV	7	320	0	ND
PEST	3	8.8	0	ND
TPH	1	26	1	14

SD-113	6/93		9/93	
PAH	12	1,400	14	3,700
TSV	14	1,500	15	3,800
PEST	6	9.7	0	ND
TPH	0	ND	1	38

SD-313	6/93		9/93	
ARO	2	62	1	14
PAH	2	50	0	ND
PHTH	1	58	0	ND
TSV	3	110	0	ND
PEST	5	12	0	ND
PCBs	1	340	0	ND
TPH	1	14	0	ND

SD-019	6/93		9/93	
ARO	1	25	0	ND
KTN	1	8	0	ND
PAH	6	250	7	1,100
PHTH	1	68	0	ND
TSV	8	360	7	1,100
PEST	7	5.9	0	ND
PCBs	1	19	0	ND
TPH	0	ND	1	17

SD-117	6/93		9/93	
KTN	1	7	0	ND
PAH	3	72	2	120
TSV	3	72	2	120
PEST	3	0.88	0	ND
TPH	0	ND	1	15

SD-030	6/93		9/93	
ARO	3	170	2	36
KTN	1	51	0	ND
PAH	5	400	1	140
PHTH	1	87	0	ND
TSV	6	490	1	140
PEST	7	10	0	ND

SD-105	6/93		9/93	
ARO	1	36	0	ND
KTN	1	31	0	ND
PAH	1	41	0	ND
TSV	1	41	0	ND
PEST	5	13	0	ND
TPH	1	24	1	46

SD-101	6/93		9/93	
KTN	1	26	0	ND
PAH	3	120	12	2,500
TSV	3	120	13	2,600
PEST	5	2.1	1	4.8

SD-103	6/93		9/93	
ARO	2	33	0	ND
KTN	1	20	0	ND
VGAS	0	ND	2	58
PAH	1	68	0	ND
TSV	1	68	0	ND
PEST	3	1.1	0	ND

SD-104	6/93		9/93	
ARO	1	110	0	ND
KTN	2	160	0	ND
HLG	0	ND	1	10
PEST	9	12	0	ND
PCBs	1	150	0	ND
TPH	0	ND	1	68

SD-020	6/93		9/93	
ARO	1	7	0	ND
PHTH	1	240	0	ND
TSV	1	240	0	ND
PEST	1	0.27	0	ND

SD-102	6/93		9/93	
ARO	1	17	1	41
KTN	2	140	1	79
HLG	1	18	0	ND
PAH	11	2,300	17	19,000
TSV	11	2,300	19	19,000
PEST	8	23	1	14
TPH	1	31	0	ND

LEGEND

Road
Railroad
Stream
Fence
Disposal Area Boundary
Iron Horse Site Boundary
Surface Water/Sediment Station
Surface Water
Building
Wetland
Canal
Lagoon

Location ID	Date		Date	
Chemical Group	No. of Analytes detected	Total Conc. of Detected Analytes	No. of Analytes Detected	Total Conc. of Detected Analytes

ND - Not Detected
NS - Not Sampled

ARO - Aromatics
KTN - Ketones
HLG - Halogenated Volatile Organics
VGAS - Volatile Gases
PAH - Polynuclear Aromatic Hydrocarbons
PHTH - Phthalates
TSV - Total Semivolatile Organics
PEST - Pesticides
TPH - Petroleum Hydrocarbons

TPH reported in mg/kg;
All other chemical groups reported in µg/kg

500 0 500
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

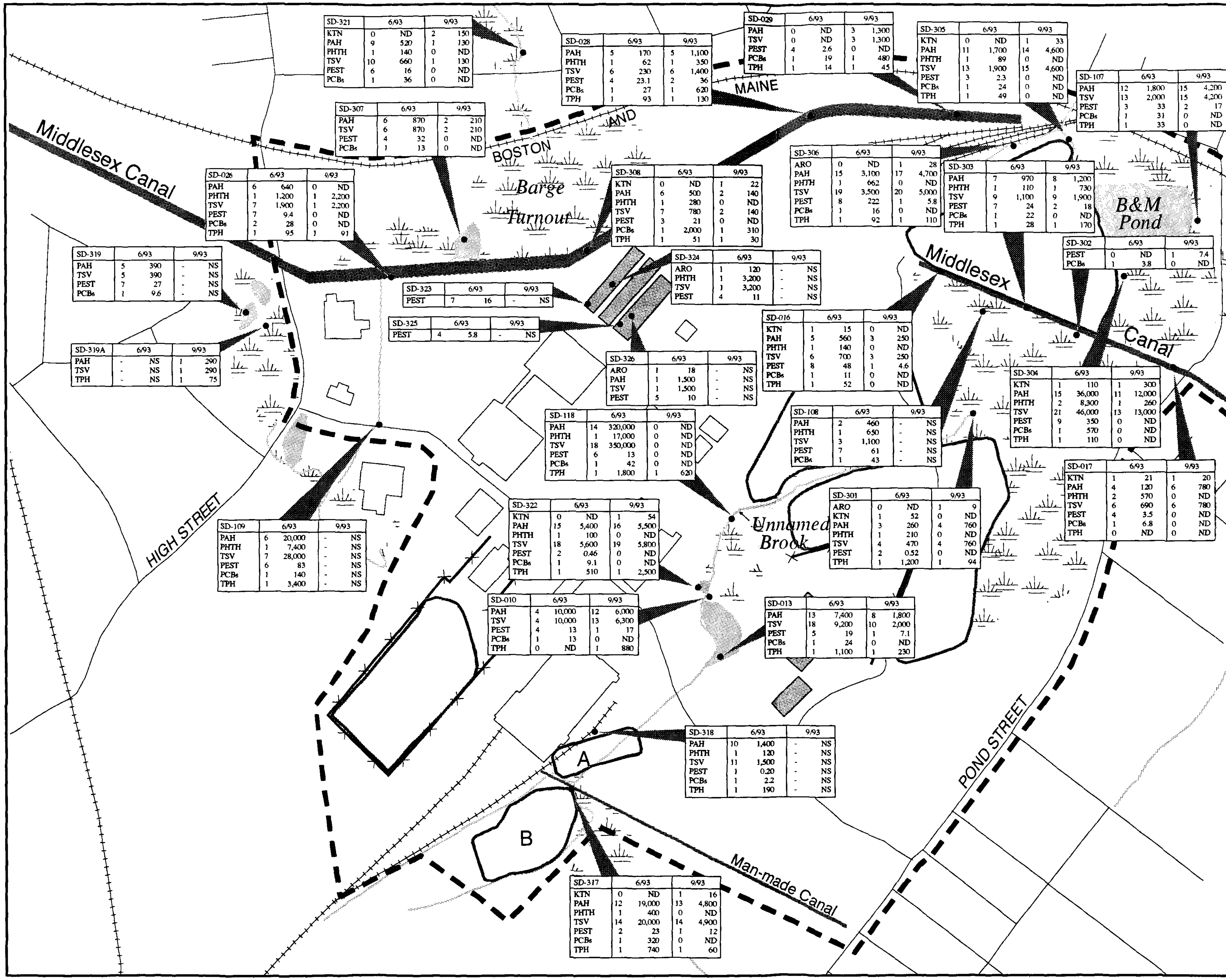
FIGURE 4-38. ORGANIC COMPOUNDS DETECTED IN SITE-WIDE SEDIMENT - EAST OF POND STREET

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-38/OrgCmpnd/SedmnVEPndSt

Original includes color coding.

Metcalf & Eddy



LEGEND

Road
Railroad
Stream
Fence
Disposal Area Boundary
Iron Horse Site Boundary
Surface Water/Sediment Station
Surface Water
Building
Wetland
Canal
Lagoon

Location ID	Date		Date	
Chemical Group	No. of Analytes detected	Total Conc. of Detected Analytes	No. of Analytes Detected	Total Conc. of Detected Analytes

ND - Not Detected
NS - Not Sampled

ARO - Aromatics
KTN - Ketones
PAH - Polynuclear Aromatic Hydrocarbons
PHTH - Phthalates
TSV - Total Semivolatile Organics
PEST - Pesticides
TPH - Petroleum Hydrocarbons

TPH reported in mg/kg;
All other chemical groups reported in µg/kg

500 0 500
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

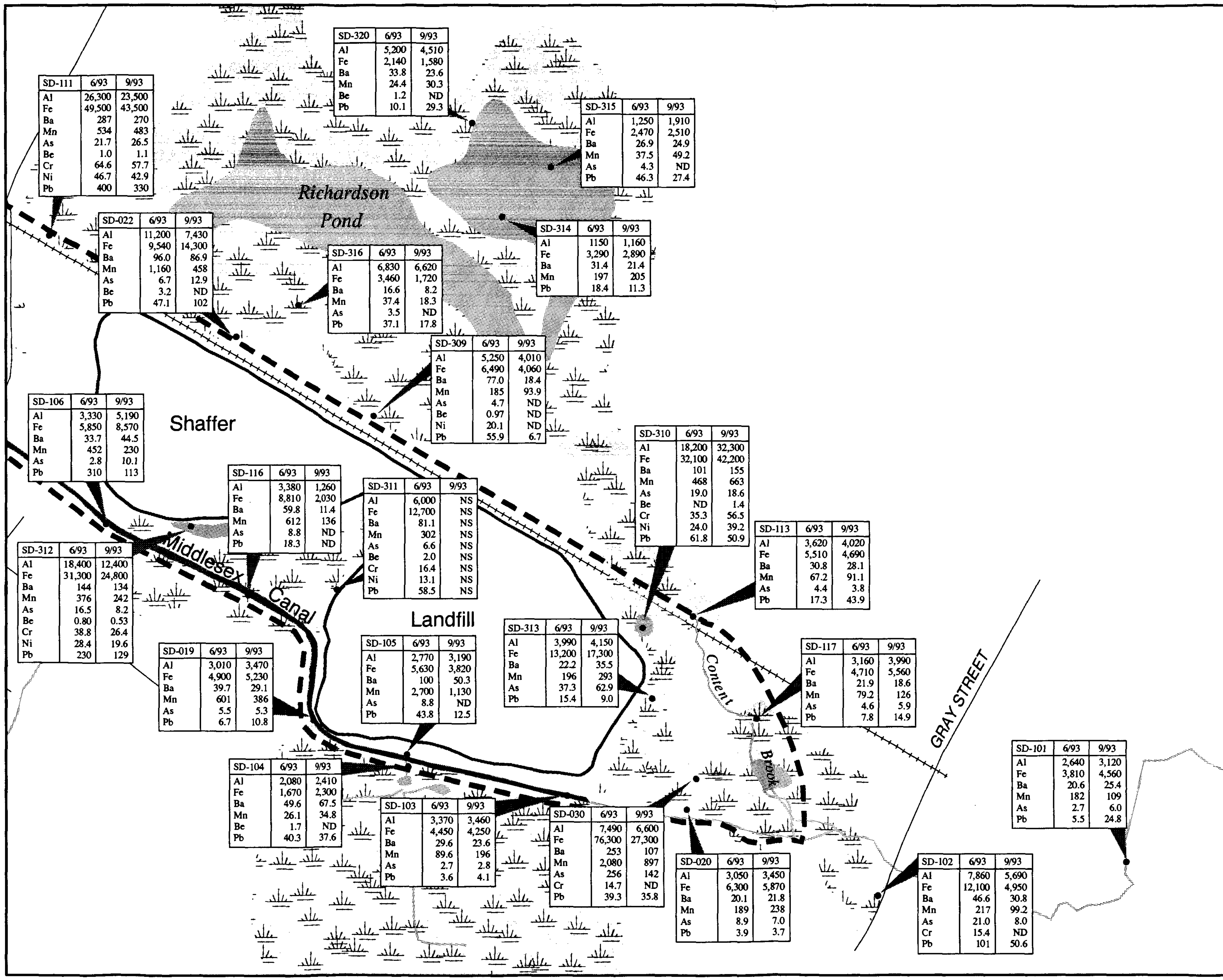
FIGURE 4-39. ORGANIC COMPOUNDS DETECTED IN SITE-WIDE SEDIMENT - WEST OF POND STREET

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-39/OrgCmpnd/SedmntWstPndSt

Original includes color coding.

Metcalf & Eddy



LEGEND

Road

Railroad

Stream

Fence

Disposal Area Boundary

Iron Horse Site Boundary

Surface Water/ Sediment Station

Surface Water

Wetland

Lagoon

Building

Canal

Concentrations reported in mg/kg

* - Not all detected metals are shown

500 0 500

SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

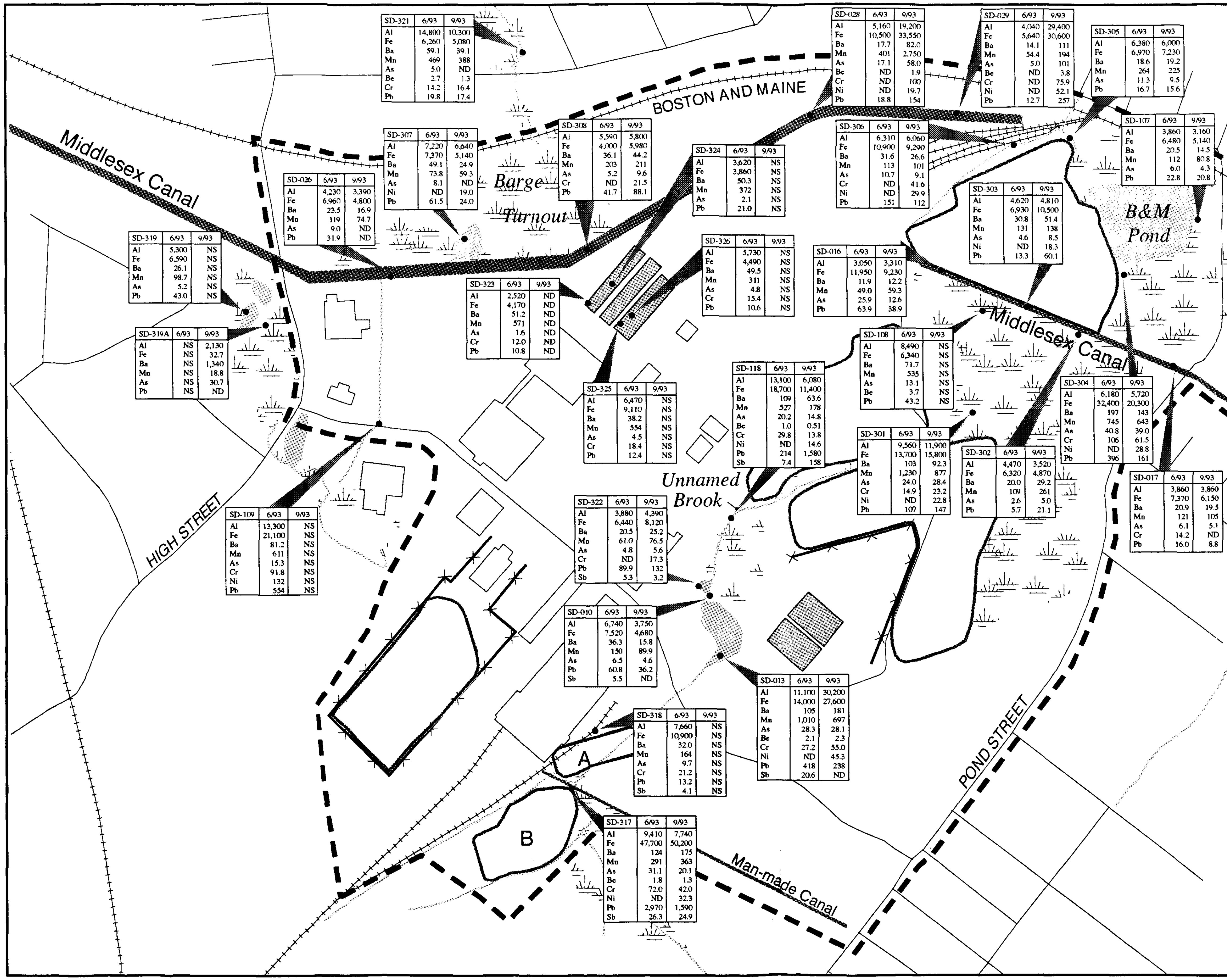
FIGURE 4-40. METALS DETECTED IN SITE-WIDE SEDIMENT - EAST OF POND STREET

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4987/4-40/Metals/Sedmnt/EPndSt

Original includes color coding.

Metcalf & Eddy



SD-321	6/93	9/93
Al	14,800	10,300
Fe	6,260	5,080
Ba	59.1	39.1
Mn	469	388
As	5.0	ND
Be	2.7	1.3
Cr	14.2	16.4
Pb	19.8	17.4

SD-307	6/93	9/93
Al	7,220	6,640
Fe	7,370	5,140
Ba	49.1	24.9
Mn	73.8	59.3
As	8.1	ND
Ni	ND	19.0
Pb	61.5	24.0

SD-026	6/93	9/93
Al	4,230	3,390
Fe	6,960	4,800
Ba	23.5	16.9
Mn	119	74.7
As	9.0	ND
Pb	31.9	ND

SD-319	6/93	9/93
Al	5,300	NS
Fe	6,590	NS
Ba	26.1	NS
Mn	98.7	NS
As	5.2	NS
Pb	43.0	NS

SD-319A	6/93	9/93
Al	NS	2,130
Fe	NS	32.7
Ba	NS	1,340
Mn	NS	18.8
As	NS	30.7
Pb	NS	ND

SD-308	6/93	9/93
Al	5,590	5,800
Fe	4,000	5,980
Ba	36.1	44.2
Mn	203	211
As	5.2	9.6
Cr	ND	21.5
Pb	41.7	88.1

SD-324	6/93	9/93
Al	3,620	NS
Fe	3,860	NS
Ba	50.3	NS
Mn	372	NS
As	2.1	NS
Pb	21.0	NS

SD-326	6/93	9/93
Al	5,730	NS
Fe	4,490	NS
Ba	49.5	NS
Mn	311	NS
As	4.8	NS
Cr	15.4	NS
Pb	10.6	NS

SD-323	6/93	9/93
Al	2,520	ND
Fe	4,170	ND
Ba	51.2	ND
Mn	571	ND
As	1.6	ND
Cr	12.0	ND
Pb	10.8	ND

SD-325	6/93	9/93
Al	6,470	NS
Fe	9,110	NS
Ba	38.2	NS
Mn	554	NS
As	4.5	NS
Cr	18.4	NS
Pb	12.4	NS

SD-028	6/93	9/93
Al	5,160	19,200
Fe	10,500	33,550
Ba	17.7	82.0
Mn	401	2,750
As	17.1	58.0
Be	ND	1.9
Cr	ND	100
Ni	ND	19.7
Pb	18.8	154

SD-029	6/93	9/93
Al	4,040	29,400
Fe	5,640	30,600
Ba	14.1	111
Mn	54.4	194
As	5.0	101
Be	ND	3.8
Cr	ND	75.9
Ni	ND	52.1
Pb	12.7	257

SD-305	6/93	9/93
Al	6,380	6,000
Fe	6,970	7,230
Ba	18.6	19.2
Mn	264	225
As	11.3	9.5
Pb	16.7	15.6

SD-306	6/93	9/93
Al	6,310	6,060
Fe	10,900	9,290
Ba	31.6	26.6
Mn	113	101
As	10.7	9.1
Cr	ND	41.6
Ni	ND	29.9
Pb	151	112

SD-107	6/93	9/93
Al	3,860	3,160
Fe	6,480	5,140
Ba	20.5	14.5
Mn	112	80.8
As	6.0	4.3
Pb	22.8	20.8

SD-303	6/93	9/93
Al	4,620	4,810
Fe	6,930	10,500
Ba	30.8	51.4
Mn	131	138
As	4.6	8.5
Ni	ND	18.3
Pb	13.3	60.1

SD-016	6/93	9/93
Al	3,050	3,310
Fe	11,950	9,230
Ba	11.9	12.2
Mn	49.0	59.3
As	25.9	12.6
Pb	63.9	38.9

SD-108	6/93	9/93
Al	8,490	NS
Fe	6,340	NS
Ba	71.7	NS
Mn	535	NS
As	13.1	NS
Be	3.7	NS
Pb	43.2	NS

SD-118	6/93	9/93
Al	13,100	6,080
Fe	18,700	11,400
Ba	109	63.6
Mn	527	178
As	20.2	14.8
Be	1.0	0.51
Cr	29.8	13.8
Ni	ND	14.6
Pb	214	1,580
Sb	7.4	158

SD-301	6/93	9/93
Al	9,560	11,900
Fe	13,700	15,800
Ba	103	92.3
Mn	1,230	877
As	24.0	28.4
Cr	14.9	23.2
Ni	ND	22.8
Pb	107	147

SD-302	6/93	9/93
Al	4,470	3,520
Fe	6,320	4,870
Ba	20.0	29.2
Mn	109	261
As	2.6	5.0
Pb	5.7	21.1

SD-304	6/93	9/93
Al	6,180	5,720
Fe	32,400	20,300
Ba	197	143
Mn	745	643
As	40.8	39.0
Cr	106	61.5
Ni	ND	28.8
Pb	396	161

SD-017	6/93	9/93
Al	3,860	3,860
Fe	7,370	6,150
Ba	20.9	19.5
Mn	121	105
As	6.1	5.1
Cr	14.2	ND
Pb	16.0	8.8

SD-109	6/93	9/93
Al	13,300	NS
Fe	21,100	NS
Ba	81.2	NS
Mn	611	NS
As	15.3	NS
Cr	91.8	NS
Ni	132	NS
Pb	554	NS

SD-322	6/93	9/93
Al	3,880	4,390
Fe	6,440	8,120
Ba	20.5	25.2
Mn	61.0	76.5
As	4.8	5.6
Cr	ND	17.3
Pb	89.9	132
Sb	5.3	3.2

SD-010	6/93	9/93
Al	6,740	3,750
Fe	7,520	4,680
Ba	36.3	15.8
Mn	150	89.9
As	6.5	4.6
Pb	60.8	36.2
Sb	5.5	ND

SD-013	6/93	9/93
Al	11,100	30,200
Fe	14,000	27,600
Ba	105	181
Mn	1,010	697
As	28.3	28.1
Be	2.1	2.3
Cr	27.2	55.0
Ni	ND	45.3
Pb	418	238
Sb	20.6	ND

SD-318	6/93	9/93
Al	7,660	NS
Fe	10,900	NS
Ba	32.0	NS
Mn	164	NS
As	9.7	NS
Cr	21.2	NS
Pb	13.2	NS
Sb	4.1	NS

SD-317	6/93	9/93
Al	9,410	7,740
Fe	47,700	50,200
Ba	124	175
Mn	291	363
As	31.1	20.1
Be	1.8	1.3
Cr	72.0	42.0
Ni	ND	32.3
Pb	2,970	1,590
Sb	26.3	24.9

LEGEND

Road
Railroad
Stream
Fence
Disposal Area Boundary
Iron Horse Site Boundary
Surface Water/ Sediment Station
Surface Water
Wetland
Lagoon
Building
Canal

Concentrations reported in mg/kg
* - Not all detected metals are shown

500 0 500
SCALE IN FEET

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

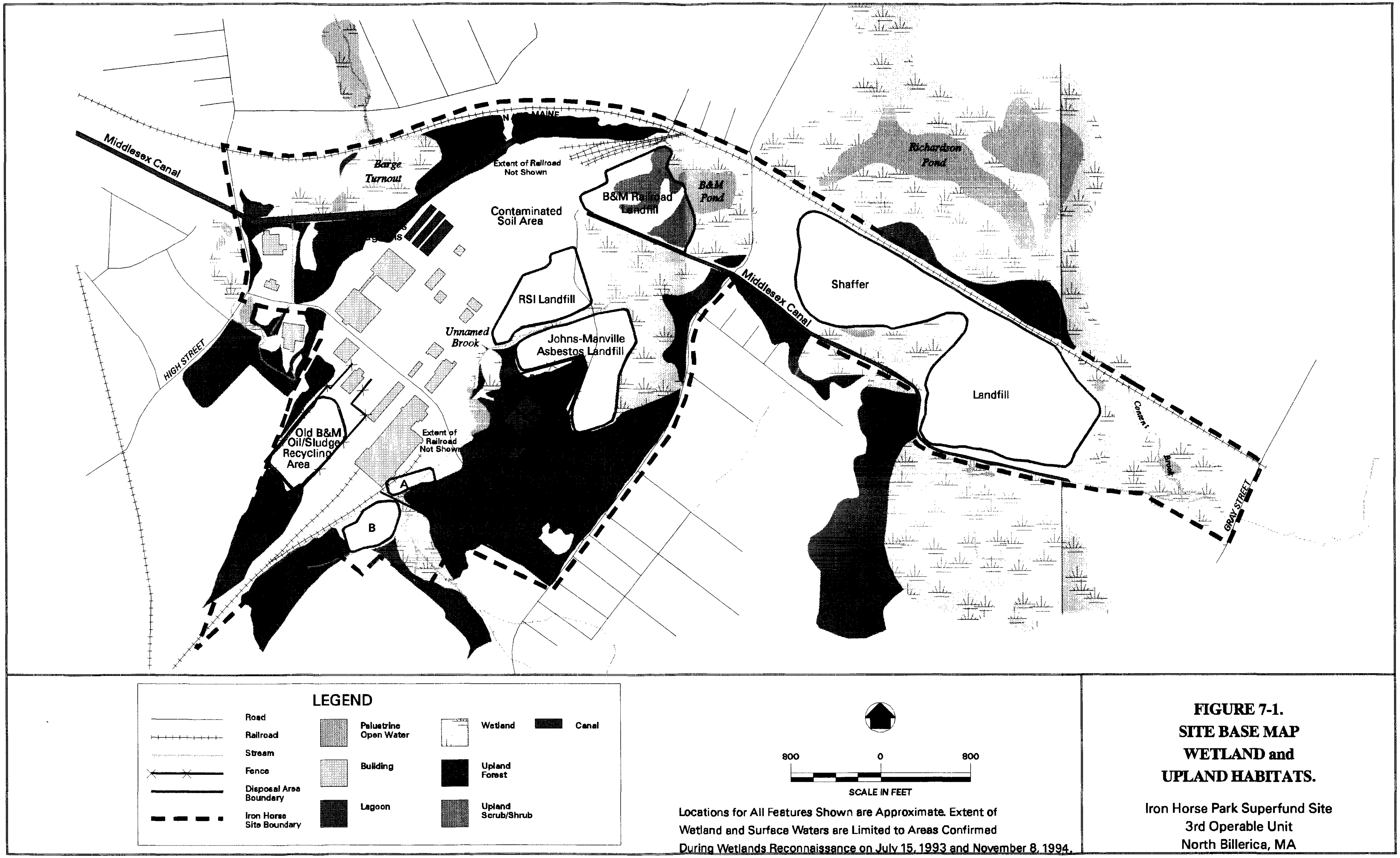
FIGURE 4-41. METALS DETECTED IN SITE-WIDE SEDIMENT - WEST OF POND STREET

Locations for All Features Shown are Approximate.
Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

4967/4-41/Metals/Sediment/WstPndSt

Original includes color coding.

Metcalf & Eddy



Locations for All Features Shown are Approximate. Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

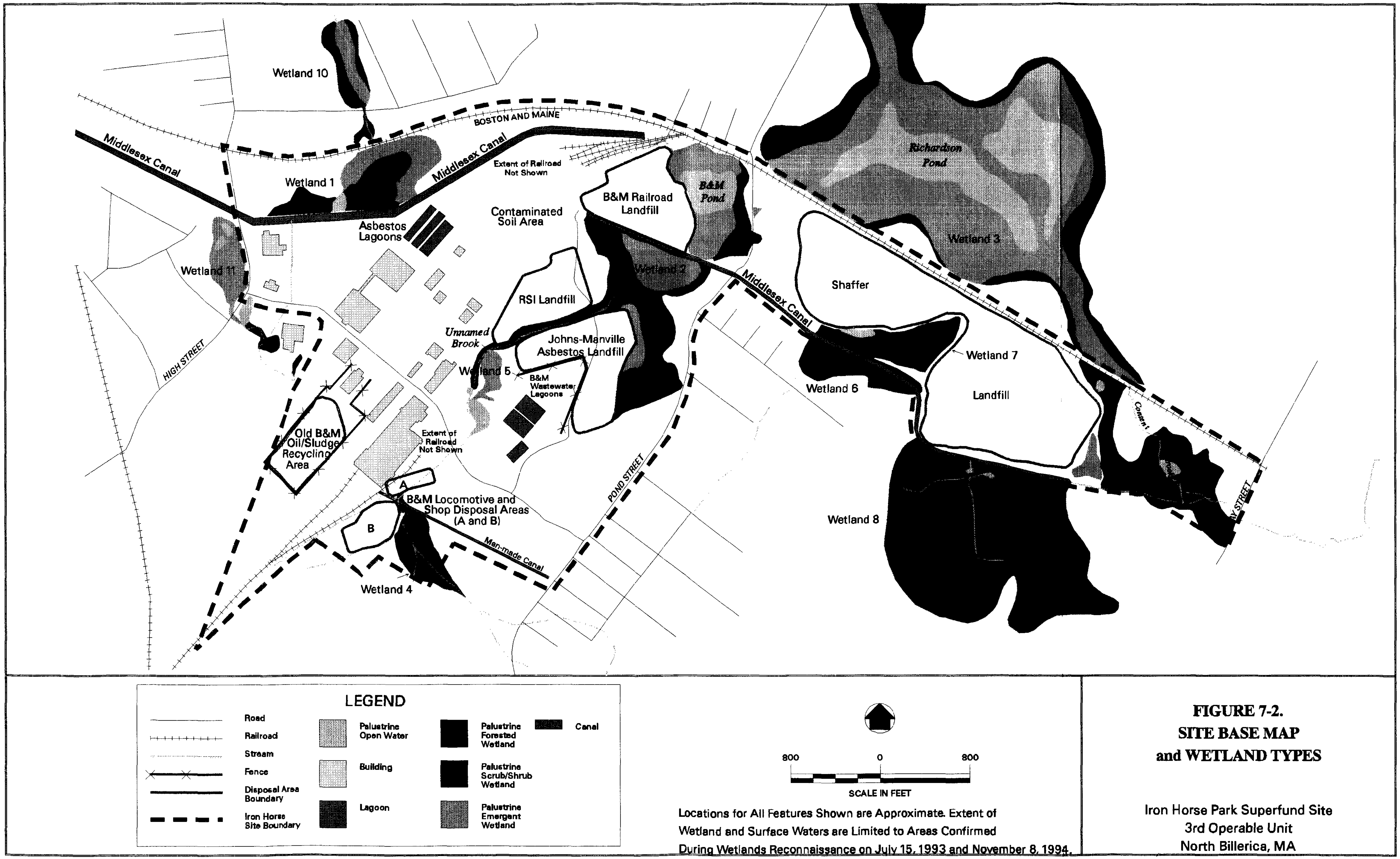
**FIGURE 7-1.
SITE BASE MAP
WETLAND and
UPLAND HABITATS.**

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

wetup.aml July 1996

Original includes color coding.

Metcalf & Eddy



Locations for All Features Shown are Approximate. Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

FIGURE 7-2.
SITE BASE MAP and WETLAND TYPES

Iron Horse Park Superfund Site
3rd Operable Unit
North Billerica, MA

wetlands.aml July 1996

Original includes color coding.

Metcalf & Eddy